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14. ABSTRACT

The Final Proceedings for International Symposium on Recent Observations and Simulations of the Sun-Earth System, 18 September 2006 - 22 September 2006. The main purpose of the symposium is to create an international forum for scientists from solar, heliospheric, magnetospheric, and earth sciences communities to present and discuss recent advances in our understanding of the structure and complex interactions of the Sun-Earth System. The focused discussions will include, but are not limited to: (1) Solar Cycle variations in the Sun-Earth system; (2) Solar dynamics and the response of geospace; (3) Production, transport, and loss of energetic particles; (4) Sun-Earth system modeling and prediction. The main emphasis will be put on the integration of these studies ~ ranging from observations to related interpretation, theory and numerical modeling — across different temporal and spatial scales of the Sun-Earth system. Participants should come away with a better realization of the dynamic nature of the space environment, while appreciating the benefits of interdisciplinary approaches to understanding the dynamic Sun-Earth system.

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International Symposium on Recent Observations and Simulations of the Sun–Earth System

PROGRAMME & ABSTRACTS

Varna, Bulgaria, September 17–22, 2006

The Symposium is sponsored by

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European Office of Aerospace Research and Development

International Living With a Star Program

International Union of Radio Science

National Aeronautics and Space Administration

US National Science Foundation

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SYMPOSIUM PROGRAMME

Sunday, September 17

09:00–11:30 *REGISTRATION*

11:30–13:00 *LUNCH*

PLENARY TALKS I

Session Chair: Vania Jordanova

13:00–13:10 ***I. Roussev, D. Sirakov***: Welcome and Introductory Remarks

SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM

SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE

15:30–15:40 *COFFEE BREAK*

PLENARY TALKS II

Session Chair: Nathan Schwadron

PRODUCTION, TRANSPORT, ACCELERATION, AND LOSS OF ENERGETIC PARTICLES

SUN–EARTH SYSTEM MODELING AND PREDICTION

18:00–19:30 **POSTER VIEWING**
Chairs: Monio Kartalev and Petko Nenovski . . . . [see 14–15]

19:30–21:30 *WELCOME RECEPTION at Grand Hotel Varna*

Monday, September 18

PLENARY TALKS III

Session Chair: Ivan Zhelyazkov

08:00–08:10 ***I. Zhelyazkov, T. Dachev***: Welcome Remarks from SU & STIL/BAS, Bulgaria

08:10–08:30 ***W. Liu, G. York***: Welcome Remarks from ILWS and EOARD

08:30–08:40 ***D. Byers***: An Overview of AFOSR Space Sciences Program (invited talk) 34

08:40–09:00 ***M. Guhathakurta***: An Overview of NASA's Living With a Star and IHY (invited talk) 49

09:00–09:20 ***P. Bellaire***: Overview of the National Science Foundation Upper Atmospheric Research Section (invited talk) 26

09:20–10:00 ***R. McPherron***: The Response of the Earth's Magnetosphere to Changes in the Solar Wind (invited talk) 73

10:00–10:15 *COFFEE BREAK*

SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM I

Session Chair: Harald Kucharek

10:15–10:40 ***J. Richardson***, *J. Kasper*: Solar Cycle Variations of Solar Wind Dynamics and Structures (invited talk) 87

10:40–11:05 ***M. Potgeiter***: Solar Cycle Variations and Cosmic Rays (invited talk) 85

11:05–11:20 ***S. Solanki***, *N. Krivova, L. Balmaceda, T. Wenzler*: The Solar Total and Spectral Irradiance since the Maunder Minimum 96

11:20–11:35 ***V. Kozlov***, *V. Markov*: Soliton-Similar Nature of 11-Year Solar Activity Cycle 63

11:35–11:50 ***K. Mursula***: Heliospheric Magnetic Field: The Bashful Ballerina Dancing in Waltz Tempo 78

11:50–12:05 ***A. Podgorny***: The Numerical MHD Simulation of Solar Flares 83

12:05–14:00 *LUNCH*

SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM II

Session Chair: Joe Borovsky

14:00–14:25 ***Y. Yermolaev***, *Y. M. Yermolaev, G. Zastenker, A. Petrukovich, L. Zelenyi*: Magnetic Storm Dependence on Solar and Interplanetary Events: Statistic Study (invited talk) 107

14:25–14:40 ***J. Johnson***, *S. Wing*: A Solar Cycle Dependence of Nonlinearity in Magnetospheric Activity 55

14:40–15:05 ***M. Denton***, *J. Borovsky, R. Skoug, M. Thomsen, B. Lavraud, M. Henderson, R. McPherron, J. Zhang, M. Liemohn*: Geomagnetic Storms Driven by CMEs and CIRs (invited talk) 39

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15:30–15:45 ***E. Tanskanen***, *H. Nevanlinna, T. Pulkkinen, A. Pulkkinen*: Solar Cycle Variation of High-Speed Stream and Auroral Region Magnetic Activity 99

15:45–16:00 *COFFEE BREAK*

Rila Monastery

SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM III

Session Chair: Judit Pap

Tuesday, September 19

SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE I

Session Chair: Ilia Roussev

08:30–08:55 ***T. Gombosi***, *G. Tóth, I. Sokolov, D. De Zeeuw, A. Ridley, W. Manchester*: Sun-to-Earth Simulations with the Space Weather Modeling Framework (invited talk) 47

08:55–09:20 ***I. Zhelyazkov***, *R. Miteva*: Waves and Instabilities in Flowing Solar Wind Structures in the Framework of the Hall Magnetohydrodynamics (invited talk) 111

09:20–09:35 ***K. Galsgaard***, *V. Archontis, F. Moreno-Insertis, A. W. Hood, and M. J. Murray*: Magnetic Flux Interaction in the Solar Corona as a Result of Magnetic Flux Emergence 43

09:35–10:00 ***G. Zank***: The Interaction of the Interstellar Medium with the Sun: Coalescence of Plasma Physics, Space Physics, and Astrophysics (invited talk) 109

10:00–10:15 *COFFEE BREAK*

SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE II

Session Chair: Jerry Goldstein

10:15–10:30 ***N. Schwadron***, *M. Desai, M. Hill, A. Posner*: On The Sources of Suprathermal Particles 90

10:30–10:45 ***V. Obridko***: Solar Cycle Variations and Cosmic Rays 80

10:45–11:00 ***N. Gopalswamy***, *S. Akiyama, S. Yashiro, G. Michalek, H. Xie, S. Petty, and R. P. Lepping*: Solar Sources and Geospace Consequences of Interplanetary Magnetic Clouds 48

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11:50–12:05 ***S. Wing***, *M. Fujimoto*: Time-Scales for the Formation of the Cold-Dense Plasma Sheet 105

12:05–14:30 *LUNCH*

SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE III

Session Chair: Charles Farrugia

14:30–14:45 ***A. Sinha***, *P. Nenovski, A. Bochev, R. Rajaram*: Geomagnetic Pulsations in Terms of Standing Alfvén Waves and their Response to Solar Wind Pressure Variation 95

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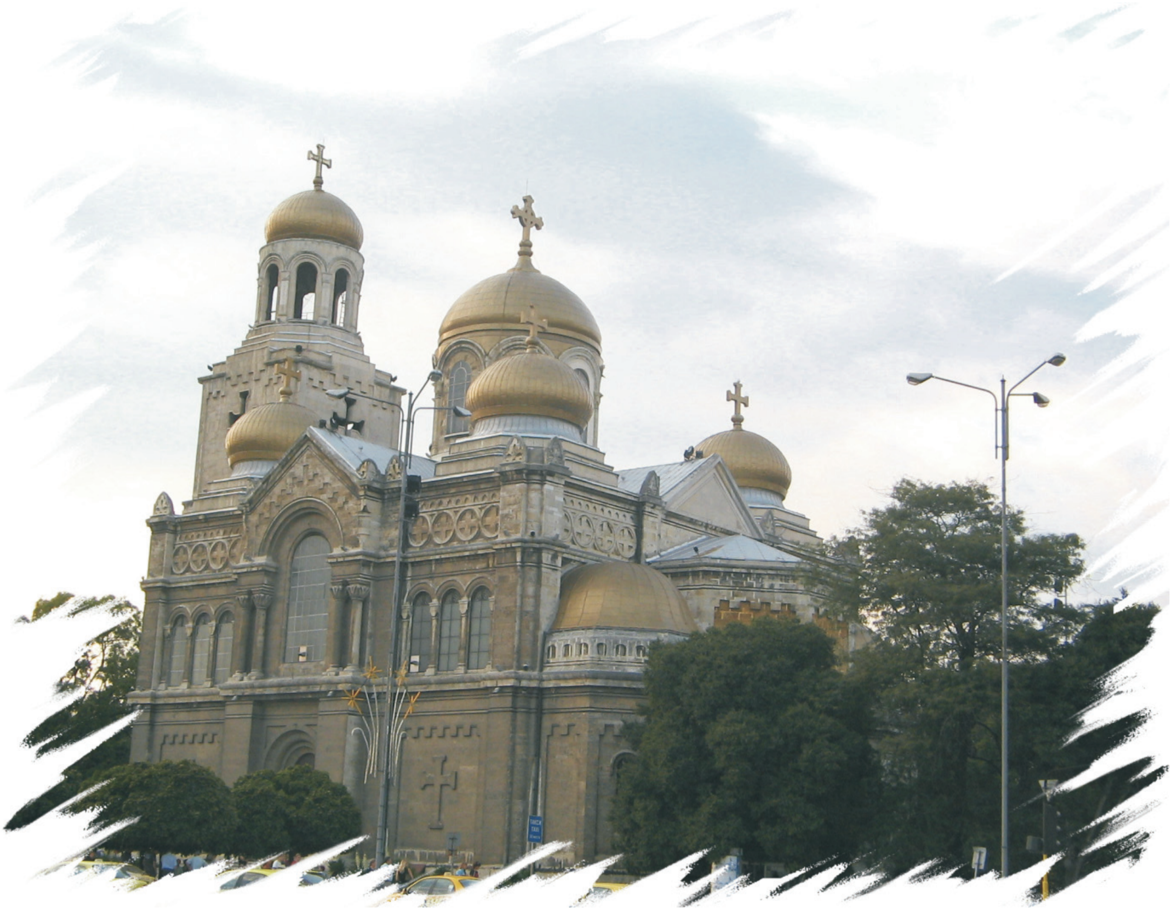
15:25–15:40 ***R. Koleva***, *J.-A. Sauvaud, A. Fedorov, V. Smirnov*: Enhanced Plasma Fluxes in the Magnetospheric Midtail Lobes 60

15:40–16:00 *COFFEE BREAK*



The Cathedral of the Assumption of the Virgin, Varna

SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE IV

Session Chair: Tamas Gombosi

19:30–20:30 *EVENING RECEPTION*

Wednesday, September 20

CLUSTER OBSERVATIONS AND THEORY

Session Chair: Maha Ashour-Abdalla

11:00–19:00 *FIELD TRIP TO NESSEBAR*

12:30–13:30 *LUNCH*

Nessebar is located on a small peninsula in the Black Sea, which is linked with the land only by a long and narrow isthmus. It has existed for more than 9,000 years. It emerged as a fortified Thracian settlement; afterwards it was a Greek colony, then a Roman and Byzantine one. The city was, once, an important trade town for the Byzantium; The largest number and best known buildings date from 11th to 14th centuries almost all of them churches in the so called “picturesque” style: walls intersected by pilasters and lunettes, with stone, brick and ceramic ornaments and arches along the cornice. Some of the churches are among the best preserved ones in the Balkan Peninsula. Today, trade activities ceased and Nessebar lives from tourism and fishing.

Thursday, September 21

PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES I

Session Chair: Joe Giacalone

10:00–10:15 *COFFEE BREAK*

PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES II

Session Chair: Richard Horne

12:05–14:30 *LUNCH*

PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES III

Session Chair: Geoff Reeves

15:40–16:00 *COFFEE BREAK*

The Roman Amphitheater, Plovdiv

PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES IV

Session Chair: Terry Onsager

19.00 *Gala Dinner at Grand Hotel Varna*

Friday, September 22

SUN–EARTH SYSTEM MODELING AND PREDICTION I

Session Chair: Klaus Galsgaard

10:00–10:15 *COFFEE BREAK*

SUN–EARTH SYSTEM MODELING AND PREDICTION II

Session Chair: Nat Gopalswamy

12:05–14:30 *LUNCH*

SUN–EARTH SYSTEM MODELING AND PREDICTION III

Session Chair: Reiner Friedel

15:40–16:00 *COFFEE BREAK*

Tzarevec, Veliko Tarnovo

SUN–EARTH SYSTEM MODELING AND PREDICTION IV

Session Chair: Vladimir Kuznetsov

POSTER VIEWING on Sunday, September 17, 2006 (18:00–19:30)

Solar Cycle Variations in the Sun–Earth System

Solar Dynamics and the Response of Geospace

Sun–Earth System Modeling and Prediction

Other Related Topics

POSTER VIEWING on Monday, September 18, 2006 (18:00–19:30)

Solar Cycle Variations in the Sun–Earth System

Solar Dynamics and the Response of Geospace

Sun–Earth System Modeling and Prediction

Cluster Observations and Theory

Other Related Topics

POSTER VIEWING on Tuesday, September 19, 2006 (18:30–20:30)

Solar Cycle Variations in the Sun–Earth System

Solar Dynamics and the Response of Geospace

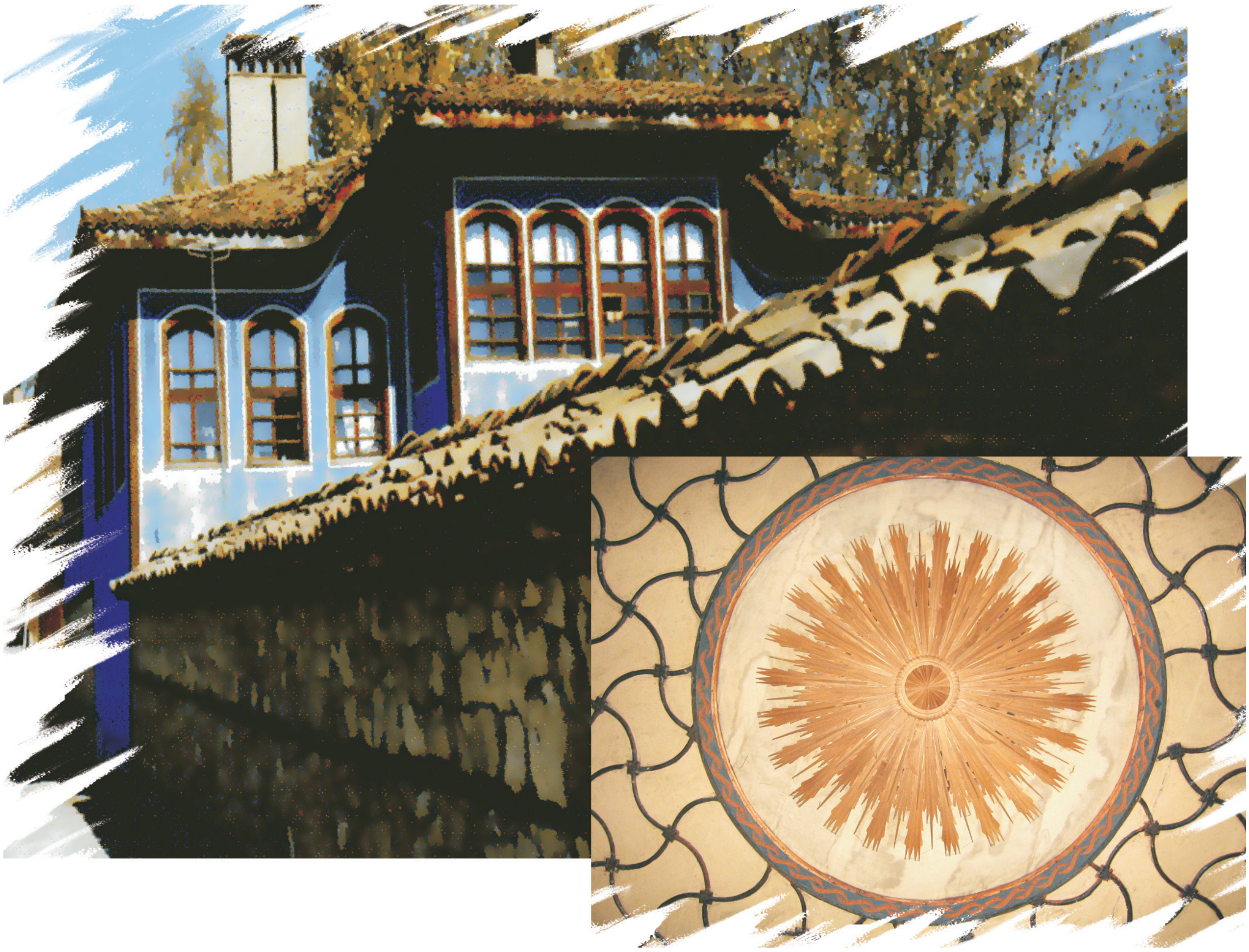
Production, Transport, and Loss of Energetic Particles

Sun–Earth System Modeling and Prediction

Other Related Topics

Note for curious people

The symbol of the Sun embedded in the Symposium logo depicts a part of the wood carved ceiling of the so called Oslekova house in the town of Koprivshtitsa.



Situated in the recesses of Sredna gora mountains, the town of Koprivshtitsa is located 112 km southeast of Sofia. The village reached its glory in XIX century culminating on April 20 1876 when the April Rebellion against the Turks burst out. Koprivshtitsa is unique place, over 300 monuments of the Bulgarian culture from the revival period have been preserved. The old houses have big eaves, stone walls and wide wooden gates. The exterior features windows, shutters, bay-windows painted blue, yellow and red.

The house-museum called Oslekova house is the most famous architectural and ethnographic monument in the town. Its owner was a rich merchant from Koprivshtitsa and the house features with its artistic carved ceilings and its walls, painted in beautiful geometrical figures.

Koprivshtitsa has a reputation of a wealthy village from the period of Bulgarian revival.

ABSTRACTS

Mechanism of Amplification and Mutual Transformation of Eigen Modes in the Ionosphere with Inhomogeneous Zonal Wind

Aburjania G.D., **Chargazia Kh.Z.**, **Kharshiladze O.A.**

I. Javakhishvili Tbilisi State University, 1 Chavchavadze Ave., GE-380028 Tbilisi, Georgia

The generation and further dynamics of planetary magnetized Rossby waves and inertia waves are investigated in the rotating dissipative ionosphere in the presence of a smooth inhomogeneous zonal wind (shear flow). Magnetized Rossby waves appear as a result of the interaction of the medium with the spatially inhomogeneous geomagnetic field and are an ionospheric manifestation of usual tropospheric Rossby waves. An effective linear mechanism responsible for the intensification and mutual transformation of Rossby and inertia waves is found. For shear flows, the operators of the linear problem are not self-adjoin, and therefore the eigenfunctions of the problem maybe no orthogonal and can hardly be studied by the canonical modal approach. Hence it becomes necessary to use the so-called nonmodal mathematical analysis. The nonmodal approach shows that the transformation of wave disturbances in shear flows is due to the nonorthogonality of eigenfunctions of the problem in the conditions of linear dynamics. Thus there arises a new degree of freedom and a new way for the evolution of disturbances in the medium. Using numerical modeling, we illustrate the peculiar features of the interaction of waves with the background flow as well as the mutual transformation of wave disturbances in the D-, E- and F-regions of the ionosphere. It is established that the presence of a geomagnetic field, Hall and Pedersen currents in the ionospheric medium, improves the interaction and mutual energy exchange between waves and a shear flow.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Treating Cross Terms in Multidimensional Diffusion of Radiation Belt Particles

Albert J.M.

Air Force Research Laboratory, Space Vehicles Directorate, 29 Randolph Road, Hanscom Air Force Base, MA 01731-3010, USA

Cyclotron-resonant wave-particle interactions are thought to be a crucial ingredient in the production and loss of energetic particles in the outer radiation belts, and are often modeled by a quasilinear diffusion equation. This equation can be written as a pure pitch angle diffusion term plus a pure energy diffusion term plus two cross diffusion terms. Spatial transport of high energy electrons is often also described by diffusion, which is usually taken to be purely in the 'radial' variable L, but there are many mechanisms whereby L couples to other variables, leading again to mixed diffusion terms and possibly a 'full' 3×3 diffusion tensor. Little attention has been paid to these mixed terms, partly because of the numerical difficulties they introduce. A technique has recently been used to rigorously transform away the cross terms in two dimensional pitch angle/energy diffusion, allowing a detailed simulation of energization by chorus waves. Here, progress is reported on extending the approach to 3D, to include pure radial diffusion and the possible additional mixed terms associated with it.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

The ELF Characterization of the Earth Ionosphere Cavity: Schumann Resonances

Altuntas E.[1], **Bahadirlar Y.**[2], **Tulunay Y.**[3], **Tulunay E.**[2,3]

[1]METU/ODTU, Department of Aerospace Engineering, TR-06531 Ankara, Turkey

[2]TUBITAK/MAM Institute of Information Technologies, TR-41470 Gebze Kocaeli, Turkey

[3]METU/ODTU, Electrical and Electronical Engineering Department, TR-06531 Ankara, Turkey

The dominant natural electromagnetic radiation in the extremely low frequency (ELF: 1100 Hz) range is due to global lightning activity. Radio waves of a few Hz frequencies traveling along the surface of the ground are able to circle the globe and return to the starting point (Hayakawa, 2004). Schumann Resonances (SR) is the electromagnetic phenomena which occur in the cavity formed by the conducting Earth and its Ionosphere having their peak frequencies close to 8, 14, 20, 26, 32 Hz, etc with slight diurnal variations. The

main source for the variations of Schumann resonance amplitudes is the global lightning activity and the changes in the diurnal SR frequency range are related to the areal variations of thunderstorm regions around the globe. (Nickolaenko and Rabinowicz, 1995; Nickolaenko et al., 1998). The spectral characteristics of the SR modes are defined by their resonant mode amplitude, center frequency and half-width (Q-factor) (Price at al. 2004). Short-term diurnal variations of these parameters are presented based on measurements at experimental sites in Gonen, near the town Balikesir and Sarkoy, near the town Tekirdag, in Turkey. The data taken every two hours for five minutes continuously with 100 Hz were analyzed and the variations of the different modes (8, 14, 20 and 26 Hz) and the different electromagnetic components (H_{ns} and H_{ew}) were presented.

The diurnal variations that were calculated for two different stations, Gonen and Sarkoy, Turkey, were found to be differing slightly from each other. The cross correlation coefficients were analyzed and found to be close to unity. This result was expected because of the geographical positions of two stations. During the analysis it was observed that there were some extreme values (peaks) occurring before the Schumann resonance modes at some specific hours (Mostly at 2400 LT and 1200 LT). These peaks were analyzed in detail to decide if they were single event upsets or peaks in the power generated by a systematic noise source.

The analysis of power variations show power maxima for the first four modes at 1400 LT despite some fluctuations in the data. In agreement with the theory it was found that as the frequency of the modes increases the power decreases. The variations of Schumann resonance mode frequencies and Q-factors were found to show complex characteristics. The diurnal variation of frequencies shows two power maxima at about 0800 LT and 1800 LT. Finally the Kp and Dst indices were analyzed to see if the analysis interval was corresponding to a magnetically disturbed or quiet period.

✓ OTHER RELATED TOPICS: POSTER

Pre-Eruptive Structure and Initiation of Coronal Mass Ejections

Amari T.

Centre de Physique Théorique, Ecole Polytechnique, F-91128 Palaiseau Cedex, France

Large-scale eruptive events such as Coronal Mass Ejections (CMEs) occur in the low solar corona where the magnetic pressure dominates the gas one. One may often observe the presence of a filaments (prominence) which is partly or totally ejected with the CME. We will review and discuss some issues related to the major class of models proposed for the pre-eruptive equilibrium configuration (and its formation) which may account for the structure and storage of magnetic energy prior to the triggering of CMEs, as well as for their initiation allowing release of energy and change of the topology.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

AE Index Forecast at Different Time Scales through an ANN Algorithm Based on L1 IMF and Plasma Measurements

Pallocchia G., **Amata E.**, **Consolini G.**, **Marcucci M.F.**, **Bertello I.**

Istituto di Fisica dello Spazio Interplenatario, INAF, I-00133 Roma, Italy

Numerous attempts to forecast the AE index have failed due to the inherent nature of AE, which appears to be a combination of a part driven by the solar wind and a part driven by internal magnetospheric processes. In this paper we present a study of the AE forecast on different time scales, from 5 min to 1 hour, based on a new ANN algorithm with L1 IMF and plasma inputs.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Comparison between Three Algorithms for *Dst* Predictions over the 2002–2005 Period

Amata E., **Pallocchia G.**, **Consolini G.**, **Marcucci M.F.**, **Bertello I.**

Istituto di Fisica dello Spazio Interplenatario, INAF, I-00133 Roma, Italy

In the past years a number of empirical models has been developed, based on differential equations and on artificial neural networks (ANN), to forecast the Dst index from solar wind IMF and plasma data time series. In this paper we compare, over the 2002–2005 period, the performance of two well known such algorithms (Wang et al, 2003, and Lundstedt et al., 2002) with the most recent ANN algorithm (Pallocchia el al., 2006), which is based on IMF data only. We show that the latter algorithm displays a better performance, especially as regards the forecasting of geomagnetic storms when Dst peaks below -150 nT. We discuss the significance of such results for operational Dst forecasting services.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

SuperDARN Observations of Northern and Southern High-Latitude Convection during a Positive B_y Period

Ambrosino D., **Amata E.**, **Marcucci M.F.**, **Coco I.**

Istituto di Fisica dello Spazio Interplenatario, INAF, I-00133 Roma, Italy

Between 2 and 3 January 2003, during a three hour interval, the IMF, as observed by ACE and WIND, flipped twice between two states: By dominated, with $B_y > 0$, and predominantly northward; B_x was always negative, apart from a few short intervals when B_x was close to 0. The solar wind dynamic pressure increased smoothly from 2 to 5 nP. In the magnetosheath the magnetic field was monitored by Geotail on the dawn flank and by Cluster close to the dusk northern high latitude magnetopause. The SuperDARN data coverage for this period is very good for both the northern and southern hemisphere and allows to analyse how high latitude convection responds to IMF turnings. We observe that, when B_y dominates, the dayside convection flows from dusk (dawn) to dawn (dusk) in the northern (sourthern) hemisphere; conversely, when $B_z > 0$, a sunward flow is observed around 12 MLT. We study in detail differences in the global convection patterns and in the time response between the northern and southern hemisphere. Due to the dipole tilt during this interval, the southern hemisphere should be favoured for lobe reconnection during northward IMF. In this respect, we suggest that the positive B_x could balance the dipole tilt effect.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

. . . .

Positions of the High Frequency Oscillations in Respect to the Solar Granulation

Andic A.

Astrophysics Research Centre, Department of Physics and Astronomy, Queen's University, Belfast, Country Antrim BT7 1NN, UK

It is thought that high-frequency oscillations are responsible for the heating of the solar chromosphere. They are generated with the 'Lighthill mechnanism' and therefore connected with the solar convection.

The data used in this work were obtained with several instruments : Vacuum Tower Telescope (VTT), Tenerife, an high cadence images sequences from the Dunn Solar Telescope (DST) at the National Solar Observatory and from TRACE. At VTT the spectral line 543.45nm was observed, using the 2D spectrometry with Fabry–Perot spectrometer. With DST the sunspot 10794 is observed using two Queen‘s developed CCD cameras: RDI (Rapid Dual Imager). One camera observed in the g-band while the other observed the blue-wing of the H-alpha core (656.1508 nm). The observations with TRACE were done with the spectral line 160nm. Speckle reconstruction technique was used for the ground based observations.

It is observed that waves exist at different heights and are located mostly above down flows, regardless on the activity of the observed area. There was a significant drop in registered oscillations above the umbra and the pore.

This indicate the connection of the oscillations with the more turbulent down flow as the main source.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

. . . .

Contribution of Solar Wind Velocity in the Earth's Space Environment Employing Low Latitude Pc3 Magnetic Pulsations

Ansari I.A.

Department of Physics, Aligarh Muslim University, Aligarh 202002, India

Energy for the Earth's magnetospheric processes is provided by solar wind. Pc3 Geomagnetic pulsations are quasi-sinusoidal variations in the Earths Magnetic field in the period range 10-45 seconds. The magnitude of these pulsations ranges from fraction of a nT(nano Tesla) to several nT. These pulsations can be observed in a number of ways. However the application of ground based magnetometer arrays has proved to be one of the most successful methods of studying the spatial structure of hydromagnetic waves in the Earth's magnetosphere. With few exceptions, the Pc3 studies undertaken in the past have been confined to middle and high latitudes. The spatial and temporal variations observed in Pc3 occurrence are of vital importance because they provide evidence which can be directly related to wave generation mechanisms both inside and external to the magnetosphere. At low latitudes ($L < 3$) wave energy predominates in the Pc3 band and the spatial characteristics of these pulsations have received little attention in the past.

An array of four low latitude induction coil magnetometers was established in south-east Australia over a longitudinal range of 17 degrees at $L = 1.8$ to 2.7 for carrying out the study of the effect of the solar wind velocity on these pulsations. Digital dynamic spectra showing Pc3 pulsation activity over a period of about six months have been used to evaluate Pc3 pulsation occurrence. Pc3 occurrence probability at low latitudes has been found to be dominant for the solar wind velocity in the range 400–700 km/s. The results suggest that solar wind controls Pc3 occurrence through a mechanism in which Pc3 wave energy is convected through the magnetosheath and coupled to the standing oscillations of magnetospheric field lines.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Predicting the Ambient Solar Wind Emerging from Sources near Active Regions

Arge C.N.[1], **de Toma G.**[2]

[1]Air Force Research Laboratory/Space Vehicles Directorate 29 Randolph Road, Hanscom Air Force Base, MA 01731-3010, USA

[2]NCAR/HAO, 3450 Mitchell Lane, Boulder, CO 80301, USA

A number of studies [Owens 2005; Arge 2004, 2003, 2000] have shown that the Wang–Sheeley–Arge (WSA) solar wind model is relatively successful at predicting the ambient solar wind speed and interplanetary polarity over the solar cycle. However, we have discovered that the model frequently fails when the source of the solar wind lies near an active region. In this paper we quantify the nature and extent of this particular failure mode over the solar cycle by considering the predictive performance of the model as a function of the proximity of a solar wind source to an active region. We then discuss possible reasons for this problem and then explore some potential methods to overcome it.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Solar Cycle Changes, Geomagnetic Storms, and Energetic Particle Properties in the Inner Magnetosphere

Baker D.N.

Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309, USA

Coordinated measurements from the Sun-Earth Connections constellation of spacecraft are presented to show the causes and effects of geomagnetic activity during recent years. It is found using multispacecraft data that even for modest geomagnetic storms, relativistic electron fluxes can be strongly and rapidly enhanced within the outer radiation zone of the Earth‘s magnetosphere. Solar wind data are utilized to identify the drivers of magnetospheric acceleration processes. Solar data (as from SOHO) are also used to identify the solar events that produce the solar wind drivers that, in turn, cause episodes of geomagnetic activity. The Earths radiation belts and inner magneto-sphere, for example, show pronounced differences in their characteristics as the Suns magnetic and solar wind properties change over the 11-year solar cycle. Solar coronal holes produce regular, recurrent solar wind stream interactions in geospace, often enhancing highly relativistic electrons (HREs) and causing recurrent magnetic storms. These phenomena are characteristic of the approach to solar minimum. This contrasts with major geomagnetic disturbances associated with aperiodic coronal mass ejections that occur most frequently around solar maximum. We present observational and modeling results that demonstrate the effects throughout the inner part of geospace during the period of the solar cycle. We place particular emphasis on long-term, homogeneous data sets from the ACE, SAMPEX, and POLAR missions. As a practical consequence of Sun-Earth connection events, it is noted that a long-lasting space weather events appear to have contributed significantly to many major spacecraft operational failures. We discuss how present and future missions can contribute to International Living With a Star (ILWS) goals.

✓ PLENARY LECTURES: ORAL

Topside Ionospheric Behaviour at Mid and Low Latitudes during Solar Minimum Conditions by Means of DEMETER and DMSP-F15 Satellites Data

Bankov L.G.[1], **Parrot M.**[2], **Vassileva A.**[1]

[1]Space Research Institute, Bulgarian Academy of Sciences, BG-1000 Sofia, Bulgaria

[2]LPCE-CNRS, F-45071 Orleans Cedex 2, France

DEMETER satellite had been launched on June 29 2004 on to circular sun-sinhronous orbit at an average altitude of 720 km in 1030–2230 LT orbital plane. Onboard instrumentation had been addressed to the global monitoring of the seismic and natural disaster effects in the Earth's topside ionosphere. A set of plasma probe instruments provides a high resolution ionospheric densities and temperatures, AC/DC electric and magnetic fields, ion drift and irregularity measurements within $\pm 60^\circ$ geographic latitudes. Fortunately, during the operation of the DEMETER satellite a regular DMSP-F15 satellite of the Defense Meteorological Satellite Program is active, which provides quite similar ionospheric plasma data at 830 km average altitude in almost the same orbital plane. Thus, we use this unique opportunity to provide a study of topside ionospheric seasonal and geomagnetic activity effects on the O^+–H^+ transition level, simultaneously at two different heights over mid and low latitudes within this local time plane.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

A Case Study of Quite Unusual Behavior of Neutral He Density over Ongoing Earthquake (Guam, January 04 1982) by means of Dynamics Explorer-b Data

Bankov L.G., **Vassileva A.**

Space Research Institute, Bulgarian Academy of Science, BG-1000 Sofia, Bulgaria

In the present work we examine a specific case of possible ionospheric plasma response due to Earth's seismic activity. By means of Neutral Atmospheric Composition Spectrometer (NACS DE-b) data we observe significant increase in neutral He density at 820 km altitude, preceding Guam earthquake at 0605UT on January 04 1982 with $M = 6.1$ of the main shock and $M = 5.8$, $M = 5.4$ for the aftershocks on 0607UT and 0615UT respectively. Neutral He concentration enhancement is of about 50% more than the observed mean value from the few lateral orbits before and after the earthquake (orb. 2280). In support of better illustration of this case we combined data from VEFI (Vector Electric Field Instrument), IDM (Ion Drift Meter) and RPA (Retarding Potential Analyser-DUCT sensor) instruments onboard DE-b satellite. As a possible explanation of such an enhancement of He we address to some possible increase in the exospheric temperature over the earthquake zone at about 300 km height as a result of energy dissipation processes of the locally generated gravity waves in a preparatory phase of the earthquake.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Combined DEMETER and DMSP Observations of the Ionospheric Effects Associated with the Chachapoyas's Earthquake (Peru – September 26 2005, M7.5)

Bankov L.G.[1], **Parrot M.**[2], **Vassileva A.**[1]

[1]Space Research Institute, Bulgarian Academy of Sciences, BG-1000 Sofia, Bulgaria

[2]LPCE-CNRS, F-45071 Orleans Cedex 2, France

In the present paper we use a chain of selected DEMETER and DMSP-F14,F15 plasma probe data within the period of few days close before and after the Chachapoyas earthquake on 0155UT, September 26 2005. Low latitude meridional profiles of plasma density and temperature measurements show significant changes during the ongoing earthquake covering a broad longitudinal zone. We observe plasma density irregularities around Magnetic Equator from the DMSP-F15 plasma probe data taken almost 15min after main shock. Similar shape of the latitudinal ion density profile could be observed even on the next DMSP-F15 low latitude pass quite away from the epicenter. As the earthquake epicenter (5.68Lat.–76.4Long) is closely situated to the Magnetic Equator in this longitudinal region, we disscus a possible scenario bottom side F-region disturbances with seismic origin to reach orbital altitude of the satellites. Evening post sunset equatorial ionosphere becomes unstable due to steepening of the bottom side F-region vertical density gradient close to the Magnetic Equator. Bottom side disturbance in the F-region could provoke an upwelling of plasma density irregularities (*i.e.* "plasma buble") up to the heights of 1000 km.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Satellite Potential and Its Link to Fotocurrent – Experiment IKB-1300

Chapkunov St., **Bankov N.**, **Shkevov R.**

Space Research Institute, Bulgarian Academy of Science, BG-1000 Sofia, Bulgaria

Information about the ionosphere plasma parameters, obtained by a corresponding set of instruments on board the ICB-1300 satellite is used. The results from the measurements along some orbits, where both presence and absence of the photocurent were detected by Langmuir probe are presented and discused

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Sudden Solar Wind Pressure Pulses Associated with a Simultaneous Northward Turning

Belenkaya E.S.

Institute of Nuclear Physics, Moscow State University, RU-119992 Moscow, Russia

It is well known that the typical response of the low-latitude northward magnetic field at the Earth surface is a simultaneous global increase. However, we have found several atypical cases, when the largest positive disturbances are observed on the night side and little or no field increase is registered near local noon. This situation often occurs when the interaction of coronal mass ejections with the

terrestrial magnetosphere presents a specific case in which a sharp increase in the dynamic pressure (interplanetary shock) is associated with a simultaneous northward turning of the interplanetary magnetic field (IMF). It was found that under these conditions, the so-called transition current system exists temporary in the high-latitude magnetosphere. We consider the dependence of the distribution of field-aligned currents in the transition current system to the radial and azimuthal components of the solar wind magnetic field.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Overview of the National Science Foundation Upper Atmospheric Research Section

Bellaire P.

Solar Terrestrial Research Program, National Science Foundation, Arlington, VA 22230, USA

The Upper Atmospheric Research Section (UARS) in NSF's Division of Atmospheric Sciences funds programs in Solar Terrestrial Research, Magnetospheric Physics, and Aeronomy. UARS also supports radar systems that study the ionosphere and magnetosphere, ground-based optical equipment to study the aurora and airglow, ground-based solar telescopes, and a broad portfolio of related research. Major activities include the Upper Atmospheric Facilities (UAF) program, the National Space Weather Program (NSWP), the Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR) program, the Geospace Environment Modeling (GEM) program, and the Solar, Heliosphere, and INterplanetary Environment (SHINE) program.

The CEDAR, GEM, and SHINE programs focus on studying solar influences on the near-Earth space environment, also know as 'geospace'. The scientific community runs the CEDAR, GEM, and SHINE workshops to encourage investigators and students to present results, exchange information, and plan future experimental campaigns.

CEDAR seeks to understand the behavior of the middle atmosphere, thermosphere, ionosphere, and exosphere, in terms of coupling energy transport, chemistry, and dynamics on regional and global scales. A database of CEDAR observations is maintained at the National Center for Atmospheric Research in Boulder, Colorado.

GEM supports research on the Earth's magnetosphere and the coupling of the magnetosphere to Earth's ionosphere and the solar wind. GEM strategy emphasizes multiple theoretical and observational campaigns, each focusing on particular aspects of the geospace environment.

SHINE research focuses upon the connections of solar magnetic and eruptive phenomena to solar wind structures propagating in the heliosphere. SHINE supports research in magnetohydrodynamics and plasma physics, and is complementary to, but distinct from, the NSWP and GEM.

The UAF program funds a chain of research radars deployed in the western hemisphere and promotes science linked to the CEDAR and GEM programs. The recent addition of the Advanced Modular Incoherent Scatter Radar (AMISR) provides an instrument deployable to any geographic location worldwide for ionospheric research.

In 2004, UARS allocated funding to create eight new tenure-track faculty positions under the Faculty Development in the Space Sciences (FDSS) program. FDSS awards were targeted to integrate solar and space physics faculty into well-established US university programs, thereby developing space physics graduate programs capable of training the next generation of space scientists.

Multiple US federal agencies support the NSWP to mitigate the effects of space weather on technological infrastructure by providing space environment observations and forecasts. As one of many NSWP success stories, NSF supports space physicists who implement and validate advanced models at the Community Coordinated Modeling Center (CCMC) located at NASA's Goddard Space Flight Center to accomplish NSWP objectives.

The NSF's Division of Atmospheric Sciences collaborates with the Division of Astronomical Sciences to support the development of the Advanced Technology Solar Telescope (ATST), the next-generation US ground-based solar telescope. The ATST is a collaboration of 22 institutions representing the US solar physics community and has several partners in Europe. Mount Haleakala on Maui in Hawaii has been selected as the potential future site for the ATST if it is approved as a Major Research Equipment Facilities Construction project for the NSF.

✓ PLENARY LECTURES: ORAL

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On Board Algorithm of Radiation Expose Forecasting for ISS Radiation Monitoring System

Benghin V.V.

State Scientific Center of the Russian Federation, Institute of Biomedical Problems, Russian Academy of Sciences,
RU-123007 Moscow, Russia

Radiation monitoring system (RMS) has worked on board of the International Space Station (ISS) practically continuously beginning from August 2001. In June 2005 the software of RMS was updated. New RMS software permits to reveal radiation environment worsening due to solar proton events and to inform crew about this. The algorithm of the on board radiation environment forecasting

is a part of the new software. This algorithm reveals dose rate increments on high latitude parts ISS orbit and calculates estimations of time intervals and dose rate values for ulterior crossings of high latitude areas.

The report contains brief description of the on board radiation expose forecasting algorithm and information of its working for September 2005 solar proton event.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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The Solar Wind Energy Input Rate to the Magnetospheric Ring Current During the Two Last Solar Cycles

Biktash L.

IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

This paper presents the recent results of our study of the solar wind energy input rate to the magnetospheric ring current in the main phase of magnetic storms. For this purpose we continued studying the solar wind parameters during the two last solar cycles. We looked for the acceptable intervals for calculation of the function of the solar wind electric field which to have use for comparison. The values of rate change of the ring current on the selected intervals of the main phases of the magnetic storms were calculated and compared with the E_y-component of the solar wind electric field. The solar wind OMNI data were used. It should be noted that the last solar cycle allow us to find the acceptable intervals for the wide range of the solar wind electric field up to 40 mV/m. These calculations show us that the relationship between rate change of the ring current and E_y-component of the solar wind remains linearly proportional for great E_y values which were observed during the last solar cycle. From this result it is evident that there is no need to use complex nonlinear models for calculation of hourly Dst index. We present the simplest algorithm for calculation the Dst-variations in order to facilitate problem of users and for the quick estimation of Dst-index from the solar wind data directly. The algorithm arises from the fact that energy input to the ring-current is proportional to the y-component of the solar wind electric field and from our physical regularities for the ring current obtained earlier. Calculations of the Dst variations on the basis of the algorithm for the geomagnetic storms of different intensity were carried out. To make allowance for the quiet magnetopause currents contribution to the Dst-index the variability of such currents in the solar activity cycles are examined.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

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The Solar Wind Control of the Ionospheric F-Layer Dynamics during Geomagnetic Storms

Biktash L.[1], **Maruyama T.**[2], **Nozaki K.**[2]

[1]IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

[2]National Institute of Information and Communications Technology, Nukuikita 4-2-1, Koganei, Tokyo 184-8795, Japan

The solar wind interplanetary magnetic field (IMF) and velocity, geomagnetic variations, virtual ionosphere height and critical frequency foF2 data during the magnetic storms are investigated to show relationships between these phenomena. We have used the geomagnetic storms during the first Western Pacific Ionosphere Campaign (1998–1999) observations when evolution of high- to low-latitude of F-region perturbations were available to trace. It is shown that mid and low latitude ionosphere dynamics during theses storms were defined by the direction of the B_z-component of the IMF and the solar wind velocity. For example, the ionospheric heights h'F and the critical frequency foF2 at mid and low latitudes during the northward IMF B_z (the quiet day conditions) and the southward IMF B_z (the main phase of magnetic storms) were very distinguished. Distinction between quiet and disturbance periods in the heights reached up to 150 km. The critical frequency foF2 was markedly lower during southward IMF B_z. We show that ionospheric dynamics can mainly be explained by the solar wind-magnetosphere-ionosphere coupling by the electric field of the field-aligned currents (FAC). The FAC electric field can penetrate throughout the mid latitude ionosphere to the equator and can serve as a coupling agent between the auroral and the equatorial ionosphere. Intensity and location of the field-aligned currents connected with DP systems mainly defined by B_z component of the IMF. Model of direct penetration of electric field from the field-aligned currents of Polar Regions 1 and Region 2 to the equatorial ionosphere is presented. Taking into account the time delay between the solar wind and the ionosphere parameters, the relationship can be used for prediction of ionosphere dynamics and could make clear a complicated picture of auroral phenomena during magnetic storms.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Diagnostics of Traveling Ionospheric Disturbances Using HF-Induced Scatter Target

Blagoveshchenskaya N.[1], **Borisova T.**[1], **Kornienko V.**[1], **Rietveld M.**[2], **Frolov V.**[3], **Yampolski Yu.**[4], **Vertogradov G.**[5]

[1]Arctic and Antarctic Research Institute (AARI), RU-199397 St. Petersburg, Russia

[2]EISCAT, N-9027 Ramfjordbotn, Norway

[3]NIRFI, RU-603950 Nizhny Novgorod, Russia

[4]Institute of Radio Astronomy of NAS, UA-61002 Kharkov, Ukraine

[5]Rostov-on-Don State University, RU-344090 Rostov-on-Don, Russia

Experimental results from Tromso and Sura heating experiments at high and mid-latitudes are examined. It was shown that the combination of HF-induced target and bi-static HF Doppler radio scatter observations is a profitable method for the identification and studies of medium-scale travelling ionospheric disturbances (TIDs) at high and mid-latitudes. Bi-static HF Doppler radio scatter observations were carried out on the London-Tromso-St. Petersburg path in the course of Tromso heating experiment on 16 November 2004 when the pump wave was reflected from auroral Es layer. During Sura heating experiments on 19 and 20 August 2004, when the HF pump wave was reflected from F2 ionospheric layer, multi-position bi-static HF Doppler radio scatter observations were simultaneously performed at three reception points including St. Petersburg, Kharkov, and Rostov-on-Don. Ray tracing and Doppler shift simulations were made for all experiments. Parameters of medium-scale TIDs were found. In all events they were observed in the evening and pre-midnight hours. TIDs in the auroral E region with periods of 20-25 min were travelling southward at speeds from 190-250 m/s. TIDs in the mid-latitudinal F region with periods from 15 to 45 min were at speeds between 40 and 120 m/s. During quiet magnetic conditions the waves were travelling in the north-east direction. In disturbed conditions the waves were moving in the south-west direction with higher speeds as compared with quiet conditions. Possible mechanisms for the AGW generation at middle and high latitudes are discussed.

✓ Solar Cycle Variations in the Sun–Earth System: POSTER

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Variations of the Ionospheric Parameters during Magnetospheric Halloween Storms

Blagoveshchensky D.[1], **MacDougall J.**[2]

[1]St. Petersburg State University of Aerospace Instrumentation, RU-190000 St. Petersburg, Russia

[2]University of Western Ontario, London, Ontario, Canada N6A 5B8

Intense solar and geomagnetic activity that had occurred on October and November, 2003 is known to be the “Halloween storms”. Active Sun’s Region 486 contained the largest sunspot group of Cycle 23. The largest flare occurred on November 4. The same region also produced an X17 on October 28, quickly followed by an X10 on October 29. The largest proton event was the 29,500 pfu, greater than 10 MeV, on October 28–29, following the X17 flare. There were two distinct, very intense geomagnetic storms associated with the X17 and X10 flares. Both these storms rank as the largest geomagnetic storms of Cycle 23. The X17 storm on October 28 is number 6 on the Top 30 list, which dates back to 1936. The X10 storm on October 29 is number 15 on the list.

The extraordinary activity caused some impacts in these areas: radiation effects on human and satellites, commercial airlines outages, electric power and other geomagnetic effects, navigation and communication: GPS effects, ionospheric disturbances, HF communication effects. Therefore, our scientific understanding of this activity is very important. Joint efforts enable progress in our ability to: (i) identify critical inputs to specify the geospace environment at a level needed to minimize impacts on technology, human society and life and (ii) support the development of robust models that predict conditions in geospace based on understanding of the Sun–Earth system and all of its interacting components. To achieve these goals, the CAWSESs (Climate and Weather of the Sun–Earth System) suggestion exists to create “One-Earth” maps. For example, an ionospheric map might include NmF2 and HmF2 variations. These latter need to (a) collect data from distributed sites and ground-based chains, (b) integrate this data into a common map, and (c) disseminate the global maps.

The goal of this paper is to reveal and compare variations of two parameters of the ionosphere, foF2 and $hmax$F2, on two chains of ionosondes located in Europe and North America during the interval 23–28 October, 2003. This interval precedes the 28–29 October Halloween storm and includes its beginning. It is important to understand, how the same geomagnetic disturbance manifests itself in different regions of the Earth. Similar investigation is useful and important for solving some Space Weather problems concerning particularly the short-term prediction of ionospheric disturbances associated with magnetospheric storms and substorms. This work was facilitated through financial support on grant NATO ESP/CLG No981604.

✓ Solar Dynamics and the Response of Geospace: POSTER

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Monitoring the Heliospheric Current Sheet Local Structure Along the Solar Cycle 23

Blanco J.J., **Rodríguez-Pacheco J.**, **Sequeiros J.**

Alcala Space Research Group, Dpto. Física, Univ. Alcalá, E-28805 Alcalá de Henares-Madrid, Spain

We have monitored the Heliospheric Current Sheet (HCS) local structure along a 10 year period starting in 1995. We used data from Wind mission instruments, mainly, the magnetic field instrument (MFI) and the solar wind experiment (SWE). Our work is focused on

the HCS local inclination and the solar wind conditions around the HCS crossings, with an especial interest on their evolution along the solar cycle. We defined a real HCS crossing when a magnetic field minimum, with a polarity reversal, is observed and $Q_e \times B$ (where Q_e is the electron heat flux in solar wind) reverses its sign in an interval no longer than of 20 minutes. This work has been supported by Spanish Ministerio de Eduacin y Ciencia into the project with reference code: ESP2005-07290-C02-01 and by Comunidad de Madrid into the project with reference code: CAM-UAH2005/007.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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Magnetospheric Magnetic Field Model with Variable Magnetopause Flaring

Bobrovnikov S.Y., **Alexeev I.I.**, **Belenkaya E.S.**, **Kalegaev V.V.**

Institute of Nuclear Physics, Moscow State University, RU-119992 Moscow, Russia

There is no exists a magnetospheric magnetic field model which completely includes the magnetopause flairing inside. However, it is very important feature of the magnetosphere. Magnetopause flaring is expected to vary due to changing conditions in the upstream interplanetary medium, related both to dynamic pressure of the solar wind, and to interplanetary magnetic field changes. We present a general formulation of the screening problem by the magnetopause currents taking into account variable magnetopause flaring. An analitical solution for the major magnetospheric magnetic field sources has been found. Theses are the tilted dipole field, tail current system and ring current. Some preliminary results for other magnetospheric sources will be presented.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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A Coordinated Study of Field-Aligned Currents and Pc5 Pulsations Dynamics during Multi-Ejecta 7-11 April 1997

Bochev A.[1], **Alex S.**[2], **Lakhina G.S.**[2], **Nenovski P.**[3], **Pilipenko V.**[4], **Teodosiev D.**[5]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Indian Institute of Geomagnetism, Mumbai 410218, India

[3]Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[4]Space Research Institute, RU-117997 Moscow, Russia

[5]Space Research Institute, Bulgarian Academy of Sciences, 6 Moskovska Street, BG-1000 Sofia, Bulgaria

Satellite observations have revealed the complexities associated with the substorm growth phase and the onset period. Processes of energy flux propagation during geomagnetic storms are mainly governed by the convection electric field in the magnetosphere through the merging of field lines. To bring out a comprehensive substorm concept a coordinated study of a few cases of substorm events, field-aligned currents, and associated Pc5 pulsations is initiated.

Distinct features of multiple substorm triggering by favorable orientation of the interplanetary magnetic field are considered in this study. Sequence of particle dispersions, field-aligned currents, and Pc5 pulsations at wide latitudinal range and different configuration of auroral oval are observed. Reconnection signatures are sought in order to understand this complexity of plasma, field, and wave features. Data from satellite observations (Interball, Polar, and DMSP) and ground based magnetic data (from Intermagnet chain of observatories at high- and mid-latitudes) are used to achieve a better spatial and temporal resolution.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Observations of Pc5 Pulsations Near Field-Aligned Current Regions Related to CMEs

Bochev A.[1], **Kudela K.**[2], **Dimitrova I.**[3], **Boshnakov I.**[1], **Nenovski P.**[4], **Troshichev O.**[5]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Institute of Experimental Physics, SAS, SK-040 10 Košice, Slovakia

[3]Space Research Institute, Bulgarian Academy of Sciences, BG-1000 Sofia, Bulgaria

[4]Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[5]Arctic and Antarctic Research Institute, RU-199397 St. Petersburg, Russia

We show examples of long period magnetic field oscillations in the field-aligned current (FAC) regions observed by Interball-Au satellite during 1996-1998 CMEs in the high latitude and mid-altitude magnetosphere. The pulsation trends are in the Pc5 range, usually in the

frequency range: 0.001–0.008 Hz. Identification of corresponding magnetosphere regions and subregions is provided by electrons and protons fluxes in the range 0.01 to 100 keV measured simultaneously on board the spacecraft. We were looking for the same type of variations in the conjugate point on the ground and at geo-synchronous orbits. Pc5 pulsations were observed more frequently in FAC region 2 on closed field lines, however an example of Pc5 event was detected poleward from the FAC region 1. We applied polarization, spectral density and intensity analyses to the FAC structures. Wind satellite observations of magnetic field and solar wind parameters were analyzed too. The results are suggestive for a parametric triggering mechanism of Pc5 pulsations that emerge in the FAC regions.

✓ Solar Dynamics and the Response of Geospace

Magnetospheric–Ionospheric Response to Large and Fast Variations in the Solar Wind Dynamic Pressure

Borodkova N.L.[1], **Huang Z.H.**[2], **Zastenker G.N.**[1], **Wang C.**[2]

[1]Space Research Institute, RAS, RU-117997 Moscow, Russia

[2]State Key Laboratory of Space Weather, Center for Space Science and Applied Research, Chinese Academy of Sciences, Beijing 100864, China

We present a comparison of large and sharp solar wind dynamic pressure changes, observed by several satellites, with fast disturbances in the inner magnetosphere. The sharp and large changes of the solar wind dynamic pressure always produce the similar disturbances in the geosynchronous magnetic field and energetic particles. Using the large statistics we found that amplitude of the geosynchronous field response strongly depends on the location of observer relative to the noon meridian, on the value of pressure before disturbances and firstly - on the amplitude of pressure change. Results of MHD simulation of geosynchronous field response for low values of solar wind pressure coincide rather well with experimental one. Several case studies have shown that solar wind dynamic pressure enhancements can increase particle precipitation and cause intensification of aurora in high-latitude ionosphere, thus leading to growth of solar wind geoeffectiveness.

✓ Solar Dynamics and the Response of Geospace: POSTER

The Response of the Magnetosphere to Solar-Wind Drivers

Borovsky J.E.

Los Alamos National Laboratory, Los Alamos, New Mexico, NM 87545, USA

The basic responses of the Earth‘s magnetosphere to the solar wind are overviewed; these responses involve the transfer of energy, momentum, and mass from the magnetosheath into the magnetosphere. Following this general discussion of solar-wind/magnetosphere coupling, the reaction of the magnetosphere to strong driving is examined. The different reactions of the magnetosphere to two different drivers in the solar wind are compared: high-speed streams and coronal mass ejections. Some outstanding questions about the solar-wind-driven magnetosphere are posed.

✓ Solar Dynamics and the Response of Geospace: ORAL

The Effect of the Plasmasphere on Geomagnetic Storms

Borovsky J.E.[1], **Denton M.H.**[2], **Hesse M.**[3], **Ridley A.J.**[4], **Lockwood M.**[2,5]

[1]Los Alamos National Laboratory, Los Alamos, New Mexico, NM 87545, USA

[2]University of Southampton, Southampton SO17 1BJ, UK

[3]CCMC, Code 612.3, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

[4]University of Michigan, Space Physics Research Lab 2455 Hayward, Ann Arbor, MI 48109-2143 USA

[5]Rutherford Appleton Laboratory Space Physics Division Space Science and Technology Department CCLRC Rutherford Appleton Laboratory Chilton, Didcot OX11 0QX, UK

The presence of a filled outer plasmasphere at the onset of strong driving changes the nature of a geomagnetic storm. Several ongoing studies by the authors are quantifying the changes. The studies involve statistical data analysis and 2-D and 3-D MHD computer simulations. The changes quantified so far deal with (1) enhanced precipitation of relativistic electrons by the outer plasma sphere prior to the storm and (2) mass loading of dayside reconnection by the plasmaspheric drainage plume resulting in a weakening of solar-wind/magnetosphere coupling. An update of these studies is given and indications of other changes caused by the plasmasphere are summarized.

✓ Sun–Earth System Modeling and Prediction: POSTER

Modeling Chorus Propagation Characteristics Using CRRES Suprathermal Fluxes

Bortnik J.[1], **Thorne R.M.**[1], **Meredith N.P.**[2]

[1]Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, CA 90095-1565, USA

[2]British Antarctic Survey, Natural Environment Research Council, Cambridge CB3 0ET, England.

Chorus is an electromagnetic plasma wave propagating in the whistler mode, and ranks as one of the most intense natural waves in the ELF/VLF frequency range. Recent work has shown that chorus waves can serve a dual role in controlling the dynamics of the Earth's outer radiation belt: firstly, chorus can act as a loss mechanism, by changing the pitch-angle of electrons near the loss-cone during cyclotron resonant interactions. Intense bursts of relativistic electrons (microbursts) in association with chorus waves have indeed been observed, and a study of the number and intensity of microbursts during the main phase of a storm has shown that lifetimes can be on the order of a day. On the other hand, theoretical studies show that chorus can act as an acceleration mechanism, increasing the energy of plasmasheet electrons to relativistic energies on the timescale of a few days. In the recent Halloween storm, it was found that the formation of a new radiation belt in the usual slot-region ($L = 2$–3) could not be accounted for with radial diffusion alone (as was traditionally believed) but that diffusion in energy due to chorus waves was necessary to account for the observed timescales. Supporting evidence for the role of chorus waves in the acceleration of radiation belt electrons has also been obtained through the observation of peaks in the phase space density as a function of L-shell, which again cannot be produced by radial diffusion alone.

In order to better understand and quantify the rates of chorus-driven acceleration and loss, it is necessary to know the propagation characteristics of chorus waves in the magnetosphere. While such studies have been performed in the past, results have often been incomplete or contradictory since a complete evolution of the chorus wave along its propagation path from its source is impossible to measure on a (single) satellite. It is our purpose to perform numerical modeling of a single chorus element from its source region, and along its entire propagation trajectory to obtain a complete temporal description of the chorus element. Using realistic suprathermal flux measurements from the CRRES satellite, we calculate the path-integrated Landau damping of the chorus wave as a function of L-shell, Magnetic Local Time (MLT), and magnetic activity (separated by AE index). We further examine the dependence of Landau damping on frequency and initial wave normal angle at the source to learn more about the generation of chorus. Finally, our calculated propagation characteristics are compared against the measured chorus wave characteristics (also on the CRRES satellite) as a check on our methodology, and as a means to infer the most likely initial parameters of the wave which would result in the observed chorus distributions.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

Application of the Mission Oriented Theory Approach to the Understanding of Cluster/Double Star Observations

Bosqued J.M.[1], **Ashour-Abdalla M.**[2,3], **El-Alaoui M.**[2], **Peroomian V.**[2]

[1]CESR/CNRS, B.P. 4346, F-31028 Toulouse Cedex, France

[2]IGPP, UCLA, 405 Hilgard Av., Los Angeles, CA 90095-1567, USA

[3]Department of Physics, UCLA, 405 Hilgard Av., Los Angeles, CA 90095-1547, USA

Recently launched multi-spacecraft missions have increased the synergy between theory, numerical simulations, and multipoint observations in the magnetosphere, resulting in a truly global assessment of the geospace environment. Multi-point near-simultaneous observations of the magnetotail and the plasma sheet by the Cluster and/or Double Star spacecraft are ideally suited for applying the mission-oriented theory approach, where global magnetohydrodynamic (MHD) simulations, local kinetic simulations, and large-scale kinetic (LSK) calculations are utilized to place spacecraft observations in the context of the dynamics of the magnetosphere.

The multiple crossings of the current sheet by Cluster at distances of 16–19 RE or 6–7 RE and of Double Star at 10–13 RE downtail are especially important in illuminating the physics of this dynamic region. Mission-oriented theory for the multi-spacecraft Cluster mission has already shed light on a number of processes occurring in the magnetotail current sheet, including the generation, acceleration, and scattering of streaming ion structures observed near the lobe/plasma sheet boundary layer. These structures are often observed with fine-scale substructures called beamlets that are caused by the alternate trapping and acceleration of ions in the magnetotail current sheet.

We will examine case studies of the generation and acceleration of ions beams and substructures observed on board the Cluster and Double Star spacecraft. To do so, we will rely on spacecraft observations and use global, time-dependent, MHD simulations and LSK calculations to trace the ions to (or from) their source region. We will also quantify the relationship between properties of ion beams observed by two or more spacecraft and the global configuration of the magnetotail.

✓ CLUSTER OBSERVATIONS AND THEORY: ORAL

Geomagnetic Pulsations as One of the Important Component of the Helio-Geophysical Disturbances Affecting the Human Health

Breus T.K.[1], **Kozyreva O.V.**[2], **Kleimenova N.G.**[2]

[1]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

[2]Institute of the Earth Physics, RAS, RU-119991 Moscow, Russia

The new heliobiological concept, proposed in the beginning of 1990, was discussed in [Breus and Papoport, 2003]. According to this concept the biological objects, including a human organism, as a complex open nonlinear systems are very sensible to the influence of noise level electromagnetic signals, which can play a significant role in its self-organization. In the process of evolution variations of natural electromagnetic fields represented the external signals forming corresponding endogenous biological rhythms. Because of that the biologic systems react to the helio-geomagnetic disturbances by unspecific adaptation stress-reaction. It could be irreversible only for so called "group of a risk". The main "target" for helio-geomagnetic disturbances is cardiovascular system. However an efficiency of different magnetic storms even with similar intensity is different. We assume that it is a result of its different wave signature.

We present here the results of the analysis of daily ambulance calls in Moscow related to myocardial infarction (MI) in period of the solar activity maximum (1979–1981). We found a similarity between the number of monthly ambulances calls for MI in Moscow and simultaneous mortality from MI in Bulgaria (A correlation coefficient is 0.84). The good correlation have been found between the days with anomalous large number of MI (MI-events) in Moscow and existence of negative B_z in the interplanetary magnetic field. The large number of MI-events were observed during a recovery phase of magnetic storm, after strong geomagnetic disturbances. Only a few MI-events occurred during the main storm phase or during several hours before the start of geomagnetic storms. We compared MI-events with the occurrence of geomagnetic Pc1 pulsations with $T \sim 1$–3 s (similar to the human heart rhythm periodicity) and found that they were observed simultaneously with high probability twice stronger than the causal one, in spite of typical minimum of Pc1 occurrence during the period of the solar activity maximum. Very often (in $\sim 80\%$ of MI-events) Pc1 pulsations were observed in previous 1-2 days. There is a similarity between a seasonal variation of Pc1 and MI with a peak in winter while other helio-geomagnetic factors have peaks in their seasonal variations during spring and autumn. It is likely that Pc1 occurrence can play a role of negative stress-reaction on the state of the cardiovascular system.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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Solar and Geomagnetic Activity Effects on Human Biological Rhythms

Breus T.K.[1], **Baevskii R.M.**[2], **Chernikova A.G.**[2], **Funtova I.I.**[2], **Kleimenova N.G.**[3], **Kozireva O.V.**[3]

[1]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

[2]Institute of Medico-Biological Problems, RAS, RU-123007 Moscow, Russia

[3]Institute of the Earth Physics, RAS, RU-119991 Moscow, Russia

The helio-geomagnetic rhythms can be external synchronizers of the biological rhythms by analogy with the solar radiation and temperature variations on premature Earth that had formed the circadian (diurnal) biorhythms. Rhythms coinciding with of 28-day solar rotation period and its harmonics and sub-harmonics (approx. 14 d, 7 d 3.5 d) as well as other very low (micro pulsations) and very high frequencies (11-yr solar cycle) are likely to reveal themselves on each level of biological systems from cells to population. The main targets for the helio-geomagnetic factors appear to be the heart and cardiovascular system (among 10 diseases for 6 000,000 ambulance calls only myocardial infarctions and sudden deaths correlated with the geomagnetic activity). During large planetary magnetic storms caused by plasma clouds from the Sun, the number of myocardial infarctions increased by 13% from 80 000 calls. Important characteristics of these helio-geomagnetic events are large negative B_z-component of interplanetary magnetic field. Biological systems are the most sensitive to the effects of these factors in state of instability. For this reason there are "groups of risk" associated with the state of adaptation: undermined (in patients), immature (in children), and burdened by other stresses (e.g. cosmonauts). Results of analysis of medical control of cosmonauts from all SOUZ spacecraft, MIR and the International Space Station expeditions reveal existence of effects of helio-geomagnetic factors. The main biotropic SA factors are Pc1 pulsations with a frequency of 0.5-2.0 Hz (close to the heart rhythm frequencies). Results based on the medical data obtained in Russia and in Bulgaria over 25 years which demonstrate Pc1 effects will be discussed.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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The Geomagnetic Effects of a Trans-Equatorial Solar Coronal Hole Crossing

Bromage B.J.I., **Birch M.J.**

Centre for Astrophysics, University of Central Lancashire, Preston PR1 2HE, UK

In June 2006 we ran a coordinated set of observations of a trans-equatorial coronal hole and the effects of its meridian crossing upon the Earth. The SOHO-CDS NIS spectrometer was used to observe the coronal hole as it crossed the disk, while about two days later

the EISCAT radar was used in multi-radar mode to observe the effects on various parts of the ionosphere during 24 hours which encompassed the complete geomagnetic event. We have also made use of available data taken routinely by a number of instruments, such as ACE and WIND (*in-situ* solar wind), POES (*in-situ* auroral particles), magnetometers (geomagnetic field), SYM_H (ring current). The aim was to follow the event from its initiation with the emanation of the solar wind from the coronal hole, through the interplanetary medium, to the development and decline of a geomagnetic substorm at the Earth. We present some of the results here.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Cosmic Ray Modeling during 11-Year Solar Cycle. Comparison with the Transport Equation and Force Field Approximation

Buchvarova M.[1], **Velinov P.**[2], **Kobylinski Z.**[3]

[1]Space Research Institute, Bulgarian Academy of Sciences, BG-1000 Sofia, Bulgaria

[2]Central Laboratory for Solar-Terrestrial Influences, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[3]University of Humanities and Economics, Faculty of Economics and Computer Science, PL-87 800 Wloclawek, Poland

Galactic and anomalous cosmic rays (modulated by the solar wind) influence strongly on the ionization state of the system ionosphere-thermosphere-middle atmospheres. We propose a model, which generalizes the differential D(E) and integral D(>E) spectra of galactic (GCR) and anomalous cosmic rays (ACR) during the 11-year solar cycle. The model takes into account the cosmic ray (CR) modulation by the solar wind. We describe the connection between solar activity variation and the values of model parameters. Our analyses show that the contribution of GCRs and ACRs to the ionization of the ionospheres of outer planets (Jupiter, Saturn, Uranus, Neptune) will increase with growth of the planetary distances from the Sun.

The modulated energy spectrum of galactic cosmic rays is compared with force field approximation and numerical solution of one-dimensional transport equation. The differences are in the order of 1 to 3%. The model solutions are compared with LEAP87, IMAX92, CAPRICE94 and AMS98 measurements, and the data from IMP-8. The limits of estimated model parameters are determined. The proposed analytical model gives practical possibility for investigation of experimental data from measurements of galactic cosmic rays and their anomalous component. The obtained parameters are used for determination of the profiles of the ionization in the ionosphere and middle atmosphere.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

On the Robustness of the Data Fitting Techniques Applied to the MHD Analysis of the Interplanetary Shock Waves

Bundova L., **Kartalev M.**

Institute of Mechanics, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

We consider the problem of the identification of the interplanetary shock waves, detected by single spacecraft plasma and magnetic field measurements, and determination of their parameters, based on Rankine–Hugoniot relations. We make use on some well developed in the literature approaches, based on nonlinear least squares fitting technique. The attention is focused on the specific logical loop lying in the basis of this kind of approaches: the procedure has to be started from some preliminary determination of the shock normal. The “fitted” pre- and post-shock parameters correspond to a new, different orientation of the shock normal. The appropriate iteration procedure reaches a convergence. The problem is that the result may vary with the starting normal orientation which is different and depend on the chosen approach for its determination. Numerical experiments, based on several approaches of normal determination are performed and the corresponding results are compared and discussed.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Evolution of Proton Nose Structures in the Inner Magnetosphere Studied with Self-Consistent Model of Electric Field

Buzulukova N.Yu., **Vovchenko V.V.**

Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

We present the results of calculation of nose structures formation in the inner magnetosphere, using numerical model of self-consistent electric field and stationary magnetic field. The considered model is similar to RCM, and computes zone II field-aligned currents and corresponding ionosphere–magnetosphere electric field. Model input parameters – cross polar cap potential, ion and electron plasma sheet temperatures and concentration at the outer boundary of model region. Model output parameters – fieldaligned currents, electric

potential, particles concentration and fluxes in the inner magnetosphere. From output parameters we reconstruct proton energy-time spectrograms, among them proton nose structures.

It is known that substorm nose structures are characterized by short time formation – less then half of hour. To explain that quick formation time, the pulse electric field in the inner magnetosphere is supposed. Using different sets of input parameters we investigate the role of cross polar cup potential, temperatures and concentrations on nose structure formation. The formation both of stationary nose structures (with constant input parameters) and substorm nose structures (with varying input) is considered. We attempt to answer the question: Can substorm nose structures be formed by self-consistent electric field or the pulse electric field is needed?

This work is partially supported by grants INTAS 03-50-4872, HIII-1739.2003.2 and MK-4085.2005.5

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

An Overview of AFOSR Space Sciences Program

Byers D.

Air Force Office of Scientific Research, USA

The AFOSR Space Sciences program seeks basic knowledge of the space environment to apply to the design and calibration of Air Force systems operating in and through space. This program's goals are to improve the global specification and forecasting of the near-Earth space environment by developing a predictive, global, coupled solar-terrestrial model.

We seek to fund research that pushes this technology forward. Current research sponsored by AFOSR focuses on fundamental plasma physics, the flow of mass, momentum, and energy through interplanetary space, turbulent plasma phenomena that mediate this flow, and other phenomena such as solar electromagnetic radiation, solar eruptive events, variable interplanetary magnetic fields and geomagnetic storm conditions.

✓ PLENARY LECTURES: ORAL

New Elements Indicating the Approach of a Deep Solar Minimum and a Dip in Climate

Callebaut D.K.

Physics Department, CGB, University of Antwerp, B-2020 Antwerp, Belgium

We gave previously (Scostep 11, Rio de Janeiro, 2006) one strong argument and 7 indications that a deep solar minimum is approaching and will occur probably in cycle 26 (uncertainty: 1 cycle). The strong argument is based on the evolution of the so-called rest-latitudes of the boundaries of the global magnetic field regions. These rest-latitudes have decreased from about 53° (upper) and 29° (lower) in cycle 12 to about 37° and 17° in cycle 23. Their average evolution is along two parallel straight lines. It was shown by Makarov, Tlatov and Sivaraman (Solar Phys., 214, 41) that a polar reversal occurs only if the annual mean Wolf number exceeds 40. Otherwise the cycle has no polar reversal, which means the cycle does not end and which we take as defining a deep minimum. According to a relation obtained by Waldmeier a Wolf number 40 corresponds to a latitude 11° where the maximum of sunspots may be found. Extrapolating the quasi-straight lines for the evolution of the rest-latitudes one obtains 11° at the end of cycle 26 as a start of a deep minimum.

Now we may add two more indications.

The rest-latitude of the boundaries of the global field regions seem to coincide practically with the conical surface where the radial variation of the angular frequency in the convective zone is zero. This location was about 37° around 1990 and has evolved now closer to 30°. That means that the upper rest-latitude has about the same lower value now, meaning that the lower rest-latitude may be very close to the limiting value 11°. That makes it probable that the deep minimum may start rather in or just after cycle 25 instead of cycle 26 or 27.

According to the eclipse pictures there seems to be an evolution from a bipolar field (say 60 years ago) to a more involved field nowadays. This corresponds to the evolution mentioned above.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Self-Consistent Analysis of the Variation of the Solar Radius with the Cycle

Callebaut D.K.

Physics Department, CGB, University of Antwerp, B-2020 Antwerp, Belgium

We expand further the self-consistent analysis elaborated by Callebaut, Makarov and Tlatov (SOLSPA-2001, 209, 2002). The variation (~ 1.2 W/m^2) in the solar constant (~ 1367 W/m^2) during a solar cycle allows a relation between the variation in solar radius ΔR and

the dept $d = (1 - \alpha)R$ in the convection zone where the expansion starts. A second relation is obtained by equating the gravitational energy required for the expansion and the decrease in luminosity during half a solar cycle. Using a linear variation in the expansion zone (0 at d and ΔR at R) results in $\Delta R \sim 8$ km and $d \sim 0.96R$ while the corresponding change in gravitational energy is $\Delta E \sim 10^{32}$ J. Now we use different profiles instead of the linear one (quadratic, cubic, ...) yielding somewhat smaller changes. Using a square root profile yields a bit larger changes. The latter profile may look odd, but it is not excluded as the region of expansion corresponds to the super-granular region.

The same method is applied to the Maunder Minimum. Estimating the temperature difference 4 times larger than in a normal cycle yields for ΔR a value 8 times larger. However, the variation in solar radius as reported by Ribes and Nesme Ribes (A&A, 276, 549, 1993) from historical observations in the Observatory of Paris is much larger.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

On the Possibility to use Stratabound Hydrothermal Crusts as Indicators for Local or Global Changes in the Environment

Rusanov V.[1], **Chakarova K.**[2], **Trautwein A.X.**[3]

[1]University of Sofia, Faculty of Physics, Department of Atomic Physics, 5 J. Bourchier Blvd., BG-1164 Sofia, Bulgaria

[2]American College of Sofia, PO Box 873, BG-1000 Sofia, Bulgaria

[3]Universität zu Lubeck, Institut für Physik, Ratzeburger Allee 160, D23538 Luebeck, Germany

Stratabound manganese oxide deposits of hydrothermal origin from Valu Fa back-arc spreading axis demonstrated a distinct layer structure. The submetal dense and porous layers were formed at two different regimes of activity of the hydrothermal sources. The mineralogical and chemical composition of the layers is different and has been studied by means of X-ray diffraction, X-ray fluorescence, and Mössbauer spectroscopy. High quality densitograms received from the X-ray topography negatives reveal the periodicity of the hydrothermal activity of the sources around the spreading axes. There is evidence that some of the periods are typical for the solar activity cycles. The porous and dense layers in the structure match exactly with the known epoch of abnormally low activity and intervals of normal activity of the Sun, respectively. It is suggested that the layer structure of the hydrothermal manganese oxide deposits is not a mere record of the hydrothermal activity of the spreading axis but contains information about the changes in the solar wind intensity. Through a very complicated chain of interactions between the solar wind intensity (actually, its magnetic field) and the magnetic field of Earth and probably directly with the magnetic dynamo that maintains the Earth‘s magnetic field in the liquid core, the magnetic field energy dissipates and affects the convective thermal motions in Earth‘s mantel. As a result of these interactions geological, seismic, and hydrothermal activities of the spreading axis have been changed. The existence of such solar-terrestrial relationships is offered for the first time and is still not well understood. Using only the main frequencies derived by the spectral analysis studies, a synthesis of the solar activity cycles and a prediction for the third millennium are performed. Two possible scenarios in the changes of the solar activity are discussed.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Acceleration and Transport of Radiation Belt Electrons by Wave-Particle Interactions: General Theory and Radial Diffusion Calculations

Chan A.A.[1], **Brizard A.J.**[2], **Elkington S.R.**[3], **Fei Y.**[1], **Wolf R.A.**[1], **Yu B.**[1], **Albert J.M.**[4]

[1]Department of Physics and Astronomy, Rice University, Houston, TX 77251-1892, USA

[2]Department of Physics, Saint Michael‘s College, Colchester, VT 05439, USA

[3]LASP, University of Colorado, Boulder, CO 80309, USA

[4]AFRL, Hanscom AFB, MA 01731, USA

Pitch-angle, energy and radial diffusion processes are all thought to play important roles in the overall transport, acceleration and loss of radiation belt relativistic electrons. Recent work on radial diffusion has emphasized enhanced radial transport during magnetic storms, including drift-resonant interactions with magnetospheric MHD waves in the ULF frequency band, whereas cyclotron resonances with EMIC waves and VLF chorus waves are often invoked for enhanced storm-time pitch-angle and energy diffusion.

Often, different theoretical formulations are used to describe the drift-resonant and cyclotron-resonant interactions, usually with specific assumptions about wave frequencies, polarizations and spatial structure. In this presentation a theory of quasilinear diffusion of relativistic electrons in general electromagnetic perturbations of arbitrary frequencies will be reviewed. Beginning with the Vlasov equation and Hamiltonian guiding center theory, a relativistic Fokker–Planck equation is obtained which contains a 3×3 diffusion tensor capable of describing transport due to electromagnetic perturbations which may break any of the three adiabatic invariants.

We have initially focused on evaluating the 3-3 element of the general diffusion tensor. The corresponding radial diffusion coefficient reproduces earlier results in the appropriate limits (such as the classic work by Falthammar [JGR, 1965, for example]), but it can be

applied to more general perturbations and to off-equatorial particle motion. Radial diffusion coefficients have also been calculated numerically, using simulations of test particles in model wave fields, and comparisons with the analytic quasilinear results show good agreement. Simulations of radiation belt electron transport in declining-phase high-speed-stream storms suggest that radial diffusion may be an especially important process in these events.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

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The Impact of Magnetic Clouds on the Magnetosphere: Parameter Study

Chané E., **Poedts S.**, **van der Holst B.**

Centrum voor Plasma-Astrofysica, Celestijnenlaan 200B, B-3001 Leuven, Belgium

Solar Coronal Mass Ejections (CMEs) are the most prominent solar drivers of the space weather. These extremely energetic phenomena travel through the heliosphere as Interplanetary (IP) magnetic clouds, often preceded by a strong and structured shock front. About 10% of these huge plasma clouds and IP shocks affect the Earth's magnetosphere and now and then result in magnetic storms in the Earth's atmosphere. Better predictions of these so-called space weather phenomena require a better understanding of the basic physics behind them. Therefore, numerical simulations of IP CME/magnetic cloud impacts on the Earth's magnetosphere are required as well as more and better observational data.

De Sterck, Low, and S. Poedts (1998, 1999a, 1999b) simulated stationary three-dimensional (3D) bow shock flows in MHD plasmas with small dissipation and showed that a new complex double-front bow shock topology arises with particular segments of the shock fronts being of the intermediate MHD shock type when the flow upstream from the obstacle is magnetically dominated. De Sterck and Poedts (2000) presented simulation results of three-dimensional (3D) stationary magnetohydrodynamic (MHD) bow-shock flows around perfectly conducting spheres. For strong upstream magnetic field a new complex bow-shock flow topology arised consisting of two consecutive interacting shock fronts. It was shown that the leading shock front contains a segment of intermediate 1-3 shock type. This was the first confirmation in 3D that intermediate shocks, which were believed to be nonphysical for a long time, can be formed and can persist for small dissipation MHD in a realistic flow configuration.

The large-scale stability of this new bow shock topology has been investigated by De Sterck and Poedts (2001). Two types of numerical experiments were done in which the upstream flow was perturbed in a time-dependent manner. It was found that large-amplitude perturbations may cause the disintegration of the intermediate shocks – which are indeed known to be unstable against perturbations with integrated amplitudes above critical values –, but that in the driven bow shock problem there are always shock front segments where intermediate shocks are reformed dynamically, resulting in the reappearance of the new double-front topology. This showed that the new bow shock topology, and shock segments of intermediate type in general, may be found in MHD plasma flows even when there are large amplitude perturbations.

In the present paper we repeat the above mentioned studies of stationary 3D MHD bow shocks mimicking the impact of magnetic clouds on the Earth's magnetosphere. However, instead of considering a perfectly conducting sphere in the solar wind plasma flow, we now consider a sphere with a dipole magnetic field. Our parameter study thus contains a magnetosphere. Moreover, we use novel shock capturing numerical techniques based on unstructured grids and parallel, implicit solvers. We investigate the same parameter domain as in the above-mentioned studies and compare the strength and the structure of the bow shock with and without magnetosphere. These are the first results of an extensive parameter study that is planned. In a later stage, we want to perform 3D time-accurate simulations of the impact of magnetic clouds on the magnetosphere and its bow shock.

References

[1] H. De Sterck, B.C. Low, and S. Poedts: Complex magnetohydrodynamic bow shock topology in field-aligned low-β flow around a perfectly conducting cylinder, *Phys. Plasmas* **5** (11), 4015–4027 (1998).

[2] H. De Sterck, B.C. Low, and S. Poedts: Characteristic analysis of a complex two-dimensional magnetodydrodynamic bow shock flow with steady compound shocks, *Phys. Plasmas* **6** (3), 954–969 (1999a).

[3] H. De Sterck and S. Poedts: Stationary slow shocks in the magnetosheath for solar wind conditions with $\beta < 2/\gamma$: 3D MHD simulations, *J. Geophys. Research* **104** (A10), 22401–22406 (1999b).

[4] H. De Sterck and S. Poedts: Intermediate shocks in three-dimensional magnetohydrodynamic bow shock flows with multiple interacting shock fronts, *Phys. Rev. Lett.* **84** (24), 5524–5527 (2000).

[5] H. De Sterck and S. Poedts, Disintegration and reformation of intermediate shock segments in three dimensional MHD bow shock flows, *J. Geophys. Research* **106** (A12), 30023–30037 (2001).

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Photoelectron Emission in Measurements of the Ionospheric Plasma Concentrations onboard Satellite 'Intercosmos Bulgaria 1300'

Chapkunov St., **Bankov N.**, **Shkevov R.**, **Buchvarova M.**

Space Research Institute of Bulgarian Academy of Sciences, BG-1000 Sofia, Bulgaria

The photocurrent effect influence on the electron and ion plasma densities measurements, made by the cylindrical Langmuir probe onboard 'Intercosmos Bulgaria 1300' is investigated. Changes in measured values are observed in the moments of probe overshadowing by the satellite body or crossing the terminator. The deviation due to the photoelectron emission of the observed electron plasma densities is estimated. The results for the concrete satellite orbit measurements are shown.

✓ Other Related Topics: POSTER

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Modeling the Intermittent Dynamics of Alfvén Waves in the Solar Wind

Chian A.C.-L.[1], **Rempel E.L.**[2], **Santana W.M.**[2], **Kamide Y.**[3]

[1]National Institute for Space Research (INPE) and World Institute for Space Environment Research (WISER), PO Box 515, São José dos Campos-SP 12227-010, Brazil

[2]Institute of Aeronautical Technology (ITA) and World Institute for Space Environment Research (WISER), São José dos Campos-SP 12228-900, Brazil

[3]Nagoya University, Solar-Terrestrial Environment Laboratory, Toyokawa 442-8507, Japan

Intermittency and chaos are fundamental nature of Sun–Earth system. We apply the dynamical systems approach to probe the intermittent dynamics of space environment, based on the numerical simulation of a nonlinear model of Alfvén waves. The role of the driver amplitude on nonlinear Alfvén waves is examined. In particular, we show that unstable periodic orbits and chaotic saddles are the basic unstable structures responsible for Alfvén intermittency driven by chaos. In addition, we demonstrate that the average duration of the quiescent phases of Alfvén intermittency follows a predicted scaling, which can be useful for space weather forecasting. The relevance of interplanetary Alfvén intermittency in driving intense geomagnetic activities will be discussed.

References

[1] Chian ACL, Kamide Y, Rempel EL, Santana WM, On the chaotic nature of solar–terrestrial environment: interplanetary Alfvén intermittency, J. Geophys. Res., in press, 2006.

✓ Sun–Earth System Modeling and Prediction: ORAL

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Modeling of Plasmasphere Flux Tube Refilling

Chugunin D.[1], **Zinin L.V.**[1,2], **Domrachev V.V.**[1]

[1]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

[2]Kaliningrad State University, RU-236041 Kaliningrad, Russia

Modeling of plasmasphere magnetic flux tube refilling by hydrodynamic TUBE-7 of ionosphere-magnetosphere dynamics model is presented. Beginning flux tube conditions were calculated by modeling of polar wind characteristics (open flux tube). Almost empty in the beginning, co-rotated flux tubes for $L = 3$–6 were refilled for many days. Calculated density profiles of refilling were approximated by simple functions. The approximated profiles were used for development of CDPDM (Convection Driven Plasmasphere Density Model) model – the model of thermal plasma density in the outer plasmasphere. Calculated plasmasphere radial density profiles are compared with satellite measurements. This work was partially supported by grants INTAS 03-50-4872 and HIII-1739.2003.2

✓ Sun–Earth System Modeling and Prediction: POSTER

Travelling Convection Vortices in the High-Latitude Ionosphere: the Role of the Solar Wind Dynamic Pressure

Coco I.[1], **Amata E.**[1], **Marcucci M.F.**[1], **Villain J.-P.**[2], **Hanuise C.**[2], **Cerisier J.-C.**[3]

[1]IFSI-INAF, I-00133 Roma, Italy

[2]LPCE-CNRS, F-45071 Orleans Cedex 2, France

[3]PSL-CETP, Saint-Maur des Fossés, F-78140 Velizy Cedex, France

Travelling Convection Vortices (TCVs) are one of the most interesting and controversial phenomena in the framework of the studies on the solar wind, magnetosphere and ionosphere coupling. Their origin, and their actual contribution to the energy transfer from the solar wind and the upper atmosphere are still subject of debate. We present here signatures of TCVs in the Northern polar cap observed after an interplanetary shock hit the Earth's magnetosphere on 6 January 1998 at 14:15 UT. Three main features emerge from observations in space: 1) the shock wave front is tilted towards daw; 2) IMF data show appreciable differences between L1 (WIND and ACE data) and just upstream of Earth's bow shock (IMP-8 data); 3) After the main shock, three minor pressure jumps are observed. The TCV dynamics is studied with both ground magnetometers and SuperDARN data. Two main vortices systems show up: a couple of vortices in the morning side, travelling towards noon, and a single vortex in the afternoon. Hints of shorter-life travelling vortices are seen in the morning, after the passage of the main TCV system. The interplanetary shock should definitively be the cause of the ground signatures, but the scenario is very complex and not univocally associable to one existing model. A brief discussion is included.

✓ Solar Dynamics and the Response of Geospace: POSTER

Numerical Models of the Background Solar Wind

Cohen O.[1], **Sokolov I.V.**[1], **Roussev I.**[2], **Gombosi T.I.**[1]

[1]Center for Space Environment Modeling, University of Michigan, Ann Arbor, MI 48109, USA

[2]Institute for Astronomy, University of Hawaii at Manoa, Honolulu, HI 96822, USA

In order to simulate space weather events, such as Coronal Mass Ejection (CME), it is important that the numerical simulation has the accurate solution for the background solar wind. The existing theoretical models for accelerating and heating the solar wind fail to reproduce the observed solar wind at 1 AU. Therefore, semi-empirical approximations are adopted for the practical purpose of numerical models. The most common approximation in use is the so-called "Potential Field Source Surface" (PFSS) approximation. The PFSS approximation enables to extract the structure of the magnetic field in the solar corona and to distinguish between open and closed field lines. Due to the observed feature of the solar wind, in which the fast solar wind originates from open field regions, and slow solar wind originates from closed field regions, the PFSS approximation is a very useful as a starting point for semi-empirical solar wind models. We will discuss the way different solar wind models (Wang–Sheeley–Arge, Fisk, Non-Uniform Polytropic Index, and Alfven Turbulence) are applied to the Space Weather Modeling Framework (SWMF) using the PFSS approximation.

✓ Sun–Earth System Modeling and Prediction: POSTER

Overview of the Space Radiation Results Obtained by Bulgarian Build Spectrometry-Dosimetry Instruments

Dachev Ts.

Solar–Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

The Liulin type instruments main purpose is to measure the specter of the deposited energy from primary and secondary particles at the aircraft altitudes, at Low Earth Orbits (LEO), outside of the Earth magnetosphere on the route and on the surface of the planets of Solar system. They are a miniature spectrometer-dosimeter containing: one semiconductor detector, one charge-sensitive preamplifier, 1 or more microcontrollers and a flash memory. First use of Liulin type spectrometers was in the Mobile Radiation Exposure Control System – Liulin-E094, flown inside of the Dosimetric Mapping experiment on American Laboratory module of ISS in May-August 2001. Next use of Liulin type system in space was in June 2005 on the Foton M2 satellite. In September of 2005 Liulin-MKC instrument was launched to the Russian segment of ISS and will be used as a part Space Radiation Service System in the Russian segment of ISS for 15 years. Two smaller modifications, named R3D-B and R3D, were developed for use on the ESA Biopan and EXPOSE facilities on Foton M type satellites and on Russian segment and Columbus module of ISS respectively. Launches in space of these instruments are scheduled for 2005 and 2006. RADOM instrument will fly on Indian Chadrayaan-1 Moon satellite for 2 years beginning in 2008. Liulin-F 2 direction dosimetric telescope is developed for the Russian Phobos-Grunt interplanetary mission beginning in 2009. For the purposes of space radiation monitoring at aircraft altitudes few modification was developed and used.

Main results from the measurements performed with the Liulin-E094 instrument on ISS, can be summarized as follows: The comparisons with the NASA Tissue Equivalent Proportional Counter (TEPC) during the flight shows good agreement between both data sets; The flight observed asymmetries in different detectors on the ascending and descending parts of the ISS orbits are described by the shielding differences generated by different geometry between the predominating eastward drifting protons and the orientation and placement of the MDUs within the ISS; The trapped proton incident spectra inside of ISS were calculated using calibration curve of MDU.

Main result from the measurements on Foton M2 satellite was the ability to be observed inner and outer radiation belts at very low altitudes and to be compared with the AP-8 MIN, AE-8 MIN and SPB97 models. Anther important result is the exact localization of the SAA center for the purposes of study of the secular changes in the position of the SAA maximum generated by the drifts in main magnetic field of the Earth.

Long term aircraft space radiation data base were accumulated in 2001–2005 years onboard of an A310-300 aircraft of Czech Air Lines, during 9 long-term (each one for about 2 months) monitoring campaign. During these flights we succeeded to perform measurements during a rare event of intense solar flare on 15th April 2001 and the subsequent Ground Level Event (GLE) 60 and in number of Forbush decreases. Aircraft data are compared with the ISS and Foton M2 data.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Field-Aligned Currents on Board of Intercosmos Bulgaria-1300 Satellite in Comparison with modeled FAC

Danov D.L., **Koleva R.**

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

The statistical large-scale field-aligned current (FAC) distribution has been demonstrated by Iijima and Potemra and by many satellite observations.

The large scale FACs are well examined experimentally and described by different (predominantly empirical/statistical) models. The aim of the present work is to compare some cases of FAC, derived from the magnetic field measurements aboard the IC BULGARIA-1300 satellite, with empirical (Tsyganenko'2001 and Paptashvili) and MHD-simulation model of large scale currents. We discuss the possible reason for the observed discrepancy between the measured and modelled FACs.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Geomagnetic Storms Driven by CMEs and CIRs

Denton M.H.[1], **Borovsky J.E.**[2], **Skoug R.M.**[2], **Thomsen M.F.**[2], **Lavraud B.**[2], **Henderson M.G.**[2], **McPherron R.L.**[3], **Zhang J.C.**[4], **Liemohn M.W.**[4]

[1]University of Southampton, Southampton SO17 1BJ, UK

[2]Los Alamos National Laboratory, Los Alamos, New Mexico, NM 87545, USA

[3]Institute of Geophysics and Planetary Physics, University of California, Los Angeles, Los Angeles, CA 90095-1567, USA

[4]University of Michigan, Ann Arbor, MI 48109, USA

The interaction of the solar wind and the Earth‘s magnetosphere is complex and the phenomenology of the interaction is very different for solar wind dominated by coronal mass ejections (CMEs) compared to solar wind dominated by co-rotating interaction regions (CIRs). We perform a superposed epoch study of the effects of CME- and CIR-dominated solar wind upon the storm-time plasma at geosynchronous orbit using data from the magnetospheric plasma analyzer (MPA) instruments onboard seven Los Alamos National Laboratory (LANL) satellites. 78 CME events and 32 CIR events are selected from the solar wind data and we examine the electron and ion plasma sheets that are formed during each type of solar wind driver, at energy-per-charge between ~ 0.1 and 45 keV/q. The results demonstrate that CIR events produce a more significant elevation in the plasma sheet temperature than ICME events, whilst CME events produce a more significant elevation in the plasma sheet density than CIR events. We attribute these differences to the average speed in the solar wind and a combination of the density of the solar wind and the ionospheric component of the plasma sheet, respectively. We also show that for CIR events, the magnitude of the spacecraft potential is, on average, significantly greater than during CME-events, with consequent effects upon the performance of instrumentation within this environment.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Comparison of Influence of Different Geomagnetic Indices on Human Physiological State

Dimitrova S.

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

A group of 86 volunteers was examined on each working day in autumn 2001 and in spring 2002. Systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate (HR) were registered. Pulse pressure (PP) was calculated. Data about subjective psycho-physiological complaints (SPPC) were also gathered. Altogether 2799 recordings were obtained. MANOVA was employed to check the significance of the influence of three factors on the physiological parameters under consideration. The factors were as follows: 1) geomagnetic activity level estimated by daily amplitude of H-component of local geomagnetic field, daily planetary Ap-index and hourly planetary Dst-index; 2) gender – males and females; 3) the presence of medication (26 persons in the group examined were on a drug treatment because of some cardiovascular complaints). Post hoc analysis was performed to elicit the significance of differences in the factors' levels. Average values of SBP, DBP, PP and SPPC of the group were found to increase statistically significantly and biologically considerably with the increase of geomagnetic indices.

✓ OTHER RELATED TOPICS: POSTER

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Data Based Model of the Magnetospheric Magnetic Field with Numerically Calculated Distribution of the Magnetopause Shielding Field

Dobreva P.[1], **Kartalev M.**[1], **Kojtchev D.**[1], **Kaschiev M.**[2]

[1]Insttitute of Mechanics, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Institute of Mathematics, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

We report on an idea of possible modification of the data based magnetospheric magnetic field models. The restrictions posed by the used mathematical approaches do not allow introduction of a enough realistic magnetopause shape in the existing data based magnetospheric magnetic field models. Even the reasonably implemented magnetopause shapes, taken there from empirical models, it has to be quite a lot geometrically idealized because of the mentioned restrictions. We propose numerically realized straightforward approach, based on finite element numerical techniques, where the magnetopause shielding field is calculated solving the Chapman–Ferraro problem. This gives in particular the opportunity to "close" the data based model by shielding field, computed on a data based magnetopause geometry. The techniques is implemented on the different variants of Tsyganenko magnetosphere models, but its utilization could be much wider, introducing arbitrary (including physics based) models of the magnetosphere current systems. Some further developments are possible, in particular "fitting" empirical magnetospheric current systems in more adequate way to the given magnetopause shape.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Influence of Magnetic Field Topology on the Dispersion of Ion Beams Accelerated in the Earth's Magnetosphere

Dolgonosov M.S.[1], **Zelenyi L.M.**[1], **Peroomian V.**[2], **Ashour-Abdalla M.**[2]

[1]Space Research Institute, Russian Academy of Sciences, 84/32 Profsoyuznaya Street, RU-117997 Moscow, Russia

[2]Institute of Geophysics and Planetary Physics, University of California, 405 Hilgard Avenue, Los Angeles, CA 90024-1567, USA

Processes occurring in vicinity of separatrix layers usually play very important role in physics of the Earth magnetosphere. Investigation of these phenomena provide now an unique opportunity of *in situ* studies of the fine structure of highly nonlinear dynamics of the Plasma Sheet Boundary Layer (PSBL) – very important dynamic region of the Earth's magnetosphere resides in the vicinity of the magnetic separatrix between open and closed field lines contains highly accelerated ion beams with complicated spatial-temporal behavior. Ionospheric footprints of these beams have been found for the first time as tiny hardy visible features at AUREOUL-3 auroral ion spectrograms and were called VDIS - velocity dispersed ion structures. Simple model explaining these dispersions as a concurrence of position dependent nonadiabatic acceleration and velocity filter effects allowed predicting a diversity of VDIS shapes in dependence of magnetic topology in a distant magnetotail. Under certain conditions fragmentation of global VDIS on a chain of smaller substructures could really be observed. All these publications assumed simple interpretation of both VDIS and beamlets comprising it as a quasipermanent spatial structures resulting from filamentation of strong PSBL plasma jets streaming earthward from distant tail

Launch of CLUSTER-II with its possibility of multipoint measurements made it possible to study this still existing spatial-temporal ambiguity in beamlets. Recently few important results from multipoint CLUSTER investigations of beamlets were presented which

brings new interest to this field. It was noticed, while the average pattern of VDIS and beamlets constituting it excellently conforms to earlier numerical simulations, dispersion of each local substructure could differ and differ significantly from the 'average' dispersion of VDIS itself. It is remarkable, that the angle of an inclination between 'average' dispersion of VDIS and local substructure can be both acute (a positive dispersion), and obtuse (a negative dispersion).

In our work the model explaining the mechanism of formation of ion beams with a positive dispersion is offered. The model is based on the numerical modeling of particle dynamics in a two-dimensional configuration of magnetic field. Unlike the previous works in this area, the source of particles in our model is asymmetric, which is more relevant of modeling of realistic conditions. Another distinctive feature of our model consist in taking into account currents carried by cross-tail particle beams, which is important for the understanding of nonlinear properties of magnetotail plasma system.

✓ CLUSTER OBSERVATIONS AND THEORY: POSTER

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Quasi Static Coupling between Magnetospheric Sheared Flows and Discrete Auroral Arcs

Echim M.[1,2], **Roth M.**[1], **De Keyser J.**[1]

[1]Belgian Institute for Space Aeronomy, B-1180 Brussels, Belgium

[2]Institute for Space Sciences, RO-76900 Bucharest, Romania

We investigate the adiabatic dynamics of precipitating particles injected into the loss cone at the magnetospheric end of a magnetic flux tube. The magnetospheric plasma flow is sheared in the direction normal to the magnetic field. A convergent perpendicular electric field is self-consistently computed for the sheared flow interface as in kinetic models of tangential discontinuities. We also consider the flux of upgoing ionospheric species and derive the net parallel flux of particles as a function of the quasi static electric potential. The current continuity on top of the ionosphere couples the vertical, field aligned currents to the horizontal, Pedersen current. The solution gives the ionospheric electrostatic potential and the field aligned potential drop as a function of latitude, self consistent magnetospheric electrostatic potential and local Pedersen conductance. We investigate the latitudinal scaling of the auroral structures as a function of the plasma temperature, density and bulk velocity at the magnetospheric boundary, as well as of the altitude of the "generator" sheared flow.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Correlation the Forbush Effects with X-ray Flares and Possibility to Use It for Short Time Prognosis

Belov A.V., **Eroshenko E.A.**, **Oleneva V.A.**, **Yanke V.G.**

Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, RU-142190 Troitsk, Russia

Not all Forbush effects are associated with the solar flares, however the biggest of them are observed after the complex of sporadic phenomena included the powerful solar flare. To study a correlation between flares on the Sun and Forbush effects near the Earth, two created in IZMIRAN data bases were combined: one database on the X-ray flares and proton enhancements, another one- on the interplanetary disturbances and Forbush effects. In the first way the cosmic ray variations were averaged by the epoch method. The mean decreases of CR density after the flares of $>$ M5 importance are sufficiently large, and time averaged profiles for eastern, central and western flares are distinguished essentially. The second way is based on an identification Forbush effects with the solar sources which was lucky to be carried for $>$ 750 events. By means of this method a statistical relation was revealed between the flare powerful and the magnitude of resulting effect in CR and the time of this effect delay relatively solar event as well. Helio latitude dependence of the Forbush effects and accompanying geomagnetic effects are found to be significantly different: location of the effective solar sources for the Forbush decreases is shifted to the east and for the magnetic storms to the west from the central solar meridian. The results obtained can be used for the short-time prognosis of the cosmic ray variations and accompanying phenomena.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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Modeling Ground Level Enhancements: the Event of 20 January 2005

Plainaki C.[1], **Belov A.V.**[2], **Eroshenko E.A.**[2], **Mavromichalaki H.**[1], **Yanke V.G.**[2]

[1]Nuclear and Particle Physics Section, Physics Department, Athens University Pan/polis-Zografos, GR-15771 Athens, Greece

[2]Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, RU-142190 Troitsk, Russia

The solar cosmic ray event associated with an X7.1 class solar flare on 20 January, 2005 was one of the greatest enhancements ever recorded by the ground level worldwide network of neutron monitors. The event occurred during a Forbush decrease, almost at the end

of the 23rd cycle of solar activity. In this work a ground level enhancement model for getting the broadest possible picture as well as for understanding the physics of solar cosmic ray particles under extreme solar conditions, is proposed. Neutron monitors responses from 41 stations widely around the Earth have been modeled to an anisotropic solar proton flux, using an optimization method, based on the Levenberg-Marquardt algorithm. The parameters of the primary solar particles outside the magnetosphere, their dynamics, as well as the characteristics of solar cosmic rays during this event are obtained and discussed.

✓ OTHER RELATED TOPICS: POSTER

Polar-DMSP Observations of Enhanced Polar Rain and Ion Fluxes on Old FTE Flux Tubes

Sandholt P.E.[1], **Farrugia C.J.**[2]

[1]Department of Physics, University of Oslo, N-0316 Oslo, Norway

[2]Space Science Center, University of New Hampshire, NH 03824, USA

During stable interplanetary conditions dominated by the IMF B_y component (= 20 nT) at the trailing edge of a magnetic cloud monitored by WIND, the Polar and DMSP F13 spacecraft made extensive measurements of polar cap precipitation and ionospheric convection at 2 altitudes and high geomagnetic latitudes. We present a study of magnetic fields, flows, field-aligned currents (FACs) and particles under a strongly eastward and slightly northward pointing IMF. Polar observed intense polar rain precipitation on top of which there were a series of ion bursts of moderate intensites and energies streaming mainly against the magnetic field. DMSP observations showed evidence for (i) antisunward flows increasing in speed toward dawn (merging cell). These were accompanied by electron fluxes, also increasing toward dawn, in keeping with expectations for large, positive IMF B_y. (ii) Duskward of these fluxes, channels of intense sunward flows were observed, indicative of the presence of lobe cell circulation embedded in the merging cell. (iii) Polar arcs were detected in conjunction with flow shears across the lobe cell indicative, in turn, of localized FACs. The twin-satellite observations are discussed in the light of recent work on the state of the magnetosphere under a strong IMF East–West component.

✓ OTHER RELATED TOPICS: POSTER

Tenuous Solar Winds: Lessons for Solar Wind-Magnetosphere Interactions

Farrugia C.J.[1], **Jordanova V.K.**[2], **Gratton F.**[3], **Ogilvie K.**[3], **Muehlbachler S.**[4], **Torbert R.**[1]

[1]Space Science Center, University of New Hampshire, NH 03824, USA

[2]Los Alamos National Laboratory, NM 87545, USA

[3]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

[4]Max-Planck Institut für Sonnensystemforschung, D-37191 Katlenburg-Lindau, Germany

During the current solar cycle there were a number of intervals of quasi-dropouts of the solar wind (density less 1 p/cc). These tenuous solar winds allow us to probe processes and properties of the magnetosphere and its coupling to the solar wind which would otherwise be masked by the effect of high density. In this presentation we shall focus on five areas where very interesting results were obtained and new insights gained: (i) the polar rain; (ii) the magnetospheric magnetic configuration; (iii) dayside erosion; (iv) ring current constants; and (v) magnetosheath waves.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

On a New Interplanetary Origin of Two-Step Geomagnetic Storms

Farrugia C.J.[1], **Jordanova V.K.**[2], **Thomsen M.F.**[2], **Lu G.**[3], **Cowley S.W.H.**[4]

[1]Space Science Center, University of New Hampshire, NH 03824, USA

[2]Los Alamos National Laboratory, Space and Atmospheric Sciences, Los Alamos, NM 87545, USA

[3]NCAR, High Altitude Observatory, Boulder, CO 80301, USA

[4]Radio and Space Science Group, University of Leicester, Leicester LE1 7RH, UK

A new view on how large disturbances in the magnetosphere may be prolonged and intensified further emerges from a recently discovered interplanetary (IP) process: the collision/merger of ICMEs (ejecta) within 1 AU. As shown in a pilot study, the merging process changes IP parameters dramatically with respect to values in isolated (pristine) ejecta. The resulting geoeffects of the coalesced ("complex') ejecta reflect a superposition of IP triggers which may result in, for example, 2-step, major geomagnetic storms. In two case studies, we isolate the effects on ring current enhancement when coalescing ejecta reached Earth. In each case, the magnetosphere

"senses" the presence of the two ejecta and responds with a re-activation of the ring current soon after it started to recover from the passage of first ejection, giving rise to a double-dip (DD), great storm. The very high (up to ∼10 p/cc) plasma sheet density, but with a decreasing trend, is the major determining factor in the intense storm activity. The plasma sheet density correlates well with the solar wind density, suggesting the compression of the leading ejecta as the source of hot, superdense plasma sheet in these cases. This correlation is similar to that obtained in a previous investigation extending over several years, but the present case studies extend the range of plasma sheet densities from ∼2 to ∼10 cm p/cc. Idiosyncracies in the behavior of the magnetopause current during these extreme events are discussed. Saturation of cross-polar cap potential and dayside erosion are present during Earth passage of the coalescing ejecta, and this aspect is investigated using AMIE data and other techniques. We suggest that interacting ejecta may be a new, important IP source of DD, major storms

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

On Possibilities of CME Onset Prediction

Filippov B.

IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

The onset of a CME is not preceded by any specific form of activity that could be recognized several days before the event. The cause of eruption is more likely in properties of coronal magnetic field equilibrium, possibly in the rapid growth of instability. The most probable initial magnetic configuration of a CME is a flux rope consisting of twisted field lines which fills the whole volume of the dark cavity stretched in the corona along the photospheric polarity inversion line. Cold dense prominence matter accumulates in the lower parts of helical flux tubes, which serve as magnetic traps in the gravitation field. So, prominences and filaments are the best tracers of the flux ropes in the corona long before the beginning of eruption. A twisted flux rope is held by the tension of field lines of photospheric sources until parameters of the system reach critical values and catastrophe happens. The flux rope height above the photosphere is one of these parameters and it is revealed by the height of the filament. We had analyzed some 70 filaments and found that eruptive prominences were near the limit of stability a few days before eruptions. We believe that a comparison of the real heights of prominences with the calculated critical heights could be a basis for predicting filament eruptions and following CMEs.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Energetic Electron Observations of Sawtooth Events in the Inner Magnetosphere Using LANL GPS Particle Instruments

Friedel R.H.W.[1], **Henderson M.G.**[1], **Varotsou A.**[1], **Reeves G.D.**[1], **Pulkkinen T.I.**[1,2], **Ganushkina N.**[2], **Cayton T.E.**[1], **Ingraham J.C.**[1], **Kubyshkina M.**[3]

[1]Los Alamos National Laboratory, Space and Atmospheric Sciences, Los Alamos, NM 87545, USA

[2]Finish Meterologiacl Institute, FIN-70211 Kuopio, Finland

[3]University of St. Petersburg, RU-191023 St. Petersburg, Russia

Los Alamos CXD energetic particle instruments on the GPS satellites are now in orbit on 6 GPS spacecraft providing an unprecedented constellation of energetic electron measurements in the inner magnetosphere from $L = 4$ outward. Sawtooth events have recently been investigated as substorm-like global events observed at geosynchronous orbit. GPS observations indicate that these sawtooth-like signatures are evident as low as $L = 4$ during the long-duration sawtooth event of March 18–20, 2006.

We use here event-oriented magnetic field models to transform GPS measurements to adiabatic invariant space at to investigate the signature of these events between geosynchronous orbit and $L = 4$. The aim is to understand the mechansims of access of these signatures to low L and to investigate the efficiency of these steady driven events for driving energetic electrons deep into the radiation belts.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Magnetic Flux Interaction in the Solar Corona as a Result of Magnetic Flux Emergence

Galsgaard K.[1], **Archontis V.**[2], **Moreno-Insertis F.**[3,4], **Hood A.W.**[2], **Murray M.J.**[2]

[1]Niels Bohr Institute, University of Copenhagen, DK-2100 Copenhagen, Denmark

[2]School of Mathematics and Statistics, University of St Andrews, Fife KY16 9SS, UK

[3]Instituto de Astrofisica de Canarias (IAC), E-38205 Tenerife, Spain

[4]Department of Astrophysics, Faculty of Physics, Universidad de La Laguna, E-38206 La Laguna, Tenerife, Spain

Part of the magnetic field that has been generated by the dynamo process deep in the convection zone, will sooner or later reach the layers of the convection zone just below the photosphere. From here, it has to build up a sufficient magnetic pressure gradient before

it can start emerging into the convective stable coronal domain. When doing so, the emerging magnetic flux encounters the existing coronal magnetic flux. Therefore, to be able for the emerging flux to make it into the corona, it has to interact with the existing coronal field. Analysis of our numerical MHD experiment show this interaction to dependent critically on the relative orientation between the two magnetic flux systems. For a large range of relative orientations, the interaction drives fears reconnection, that on a dynamical time scale can, significantly, changes the connectivity of the magnetic flux. During the 3D reconnection event, we find both plasmoid and high velocity outflows.

These finding and their implications for the evolution of the coronal environment will be discussed in the talk.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Latitudinal and Longitudinal Structures and Dynamics of Solar Magnetic Field

Gavryuseva E.

Arcetri Astrophysical Observatory, I-50125 Florence, Italy

Observations of the large scale magnetic field in the photosphere taken at the Wilcox Solar Observatory since 1976 up to 2005 have been analyzed to deduce its latitudinal and longitudinal structures, its differential rotation, and their variability in time. The main results are the following:

– The latitudinal structure of the solar magnetic field with a period of polarity change of 22 years consists of four zones: two sub-polar and two near-equatorial with boundaries around +25, 0, and -25 degrees.

– The presence of the polarity waves running from the equator to the poles with quasi 2.5-year period has been clearly demonstrated.

– North-South asymmetry of solar magnetic field and its short and long term variability in time have been studied.

– Differential rotational rate of the magnetic field and its temporal dependence has been evidenced at different latitudes through activity cycles.

– Extremely interesting quasi-stable over 30 years longitudinal structure has been found. Its relation to the latitudinal topology of the magnetic field was studied.

– Longitudinal structures in different coordinate systems rotating differentially like the photosphere does and with different constant rates were reconstructed.

These results are fundamental for the understanding of the magnetic origin of the solar activity, dynamics, heliospheric structure and for the prediction of the solar wind and magnetospheric perturbations.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Comparison of the Photospheric Field Topology with Variability of Solar Wind and Geomagnetic Perturbations

Gavryuseva E.

Arcetri Astrophysical Observatory, I-50125 Florence, Italy

Relationships between the photospheric magnetic field, interplanetary field, solar wind characteristics near the Earth orbit and geomagnetic perturbations was studied using WSO observations of large scale magnetic field of the Sun (SMF) and OMNI data taken since 1976 to 2005. Connection between SMF and interplanetary magnetic field (IMF) was analyzed on a short time scale (day-to-day comparison) for several years during minimum and maximum of solar activity and after the polarity change at high latitudes) to reveal the efficient delay between the processes on the Sun and on the Earth orbit.

The correlation between the temporal behaviour of SMF and IMF solar wind characteristics and geomagnetic perturbations was calculated for data sets of 29-year long and for the short subsets to reveal the heliolatitudes where the solar wind is originate from and how they depend on the phase of the activity.

Such approach to the problem of SOLAR–TERRESTRIAL relations helps to find physical connections between the processes on the way from the Sun to the Earth. These results are useful for the understanding of the heliospheric structure and for the prediction of the magnetospheric perturbations.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

A Review of GOES X-ray Data over the Solar Cycle 23

Gburek S.

Space Research Centre, Polish Academy of Sciences, Solar Physics Division, Kopernika 11, PL-51 622 Wrocław

Solar X-ray observations recorded by the series of Geostationary Observational Environmental Satellites (GOES) are analyzed in the present study over a time scale of solar cycle 23. Statistical analysis of a large database of GOES events is performed. Time correlations between GOES X-ray events and space weather events are presented. The possible applications of GOES X-ray measurements to space weather forecasting are discussed.

✓ OTHER RELATED TOPICS: POSTER

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Space Weather Forecast Models from the Center for Integrated Space Weather Modeling

Gehmeyr M.[1], **Arge C.N.**[4], **Mayer L.**[1], **Odstrcil D.**[1], **Owens M.**[2], **Rigler J.**[5], **Vassiliadis D.**[6], **Weigel R.**[3]

[1]University of Colorado, Boulder, CO 80309, USA

[2]University of Boston, Boston, MA 02215 MA, USA

[3]George Mason University, Fairfax, 22030, USA

[4]Air Force Research Laboratory, 29 Randolph Road, Hanscom Air Force Base, MA 01731-3010, USA

[5]National Center for Atmospheric Research, Boulder, CO 80307-3000, USA

[6]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

One main objective of the Center for Integrated Space Weather Modeling (CISM) is to develop forecast models (FM) for the Sun-Earth chain and mature them close to the operational stage. All models are based on science models from research conducted at the center. The Sun-Earth chain comprises of empirical and physical models. Among the former are a 1 to 7-day prediction of the daily Ap and solar wind speed at L1, and a 1-day prediction of the relativistic electron flux in the 2–9 MeV energy channel for L-shells between 1.1 and 10. Among the latter is the Ambient Solar Wind FM. It is driven by daily NSO synoptic maps; we employ the Wang–Sheeley–Arge algorithm to transform these into inner boundary conditions for a MHD code; we apply the ENLIL code to propagate the structures of the ambient solar wind out to Earth and beyond. An important step in the transition from science to forecast models is validation. We discuss methods, define suitable metrics, and report on the validation findings for the various models.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Solar Cycle Variations in the Sun–Earth System: Upper Atmosphere Aspects

Georgieva K.[1], **Kilifarska N.**[2], **Rozelot J.-P.**[3]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[3]Observatoire de la Côte d'Azur, F-06304 Nice Cedex 4, France

Solar activity effects in the upper atmosphere are much stronger than in the troposphere. However, the effects in the upper atmosphere are very complicated, depending on altitude, latitude, longitude, local time, season, and on the background state of the atmosphere. Furthermore, the atmospheric response may differ for different solar activity manifestations, such as total and spectral solar irradiance, mass ejecta, or high speed solar wind, whose variations are different throughout the sunspot cycle. The existing models describing the solar cycle variations in the upper atmosphere account mainly for the effects of the irradiance variations. Here we summarize what is known about the solar cycle variations in total and spectral solar irradiance and their effects on the upper atmosphere, and compare with the less studied effects of coronal mass ejections and high speed solar wind from solar coronal holes, and their relative importance at different phases of the sunspot cycle.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

A New Theory for the Acceleration of Electrons by Shocks

Giacalone J., Jokipii J.R.

University of Arizona, Tucson, AZ 85721-0092, USA

We discuss the physics of the acceleration of fast, low-rigidity charged particles (such as electrons) by collisionless shocks or compressions. We show that large-scale turbulent magnetic fields that are known to exist in astrophysical plasmas such as the solar wind, have an important affect on these particles. In particular, fast-moving electrons can follow meandering lines of force that intersect the shock in many places. This leads to a trapping of the electrons and efficient acceleration by the shock and or compression. This is similar to standard diffusive shock acceleration, except that resonant pitch-angle scattering is not required. Furthermore, because the field lines intersect the shock in more places when the background field is normal to the shock propagation direction, this process is expected to work most effectively at nearly perpendicular shocks. Implications of our study to our understanding of solar-energetic particles and the interpretation of spacecraft observations will be discussed.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Response of the Atmospheric Ozone and the Surface UV Radiation to the Solar Dynamics

Gogosheva Ts.[1], Grigorieva V.[2], Mendeva B.[3], Krastev D.[3], Petkov B.[3,4]

[1]Institute of Astronomy, Bulgarian Academy of Sciences, BG-1784 Sofia, Bulgaria

[2]Institute of Electronics, Bulgarian Academy of Sciences, BG-1784 Sofia, Bulgaria

[3]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[4]Institute of Atmospheric Sciences and Climate, National Research Council, I-40129 Bologna, Italy

A response of the atmospheric ozone to the solar radiation variability has been studied, using the total ozone content (TOC) data, taken from the satellite experiments GOME on ERS-2 and TOMS-EP as well as data from the ground-based spectrophotometer “Photon”, operating in Stara Zagora, Bulgaria, in the period 2000–2005. The sunspot daily numbers W and the solar radio flux at 10.7 cm (F10.7) have been taken as parameters, characterizing the solar activity. The impact of the solar activity on TOC has been studied, analyzing the ozone response to sharp changes of parameters W and F10.7. Some of the examined cases show a positive correlation between TOC and F10.7 (as the increase of W and F10.7 corresponds to an increase of TOC) and a negative correlation is found in the other cases.

The changes in the solar radiation intensity during eclipse can be examined as a particular case of the solar dynamics. The measurement of the UV surface radiation in time of an eclipse and the calculation of the total ozone through it give us an idea about the effect of this kind of solar dynamics on the ozone.

The measurement of the total ozone amount during the solar eclipse on 11 August 1999 was performed in Stara Zagora. The data show that after the first contact TOC begins to decrease till the maximum obscuration. In the maximum phase (96%) the ozone reaches a value of about 14% less than that on the control day. Almost 5 minutes after the maximum coverage it sharply increases, reaching a level higher than that on the control day. The UV surface radiation measurements show that the decrease of the solar flux intensity during an eclipse is different for the separate wavelenghts.

The solar radiation affects the ozone behaviour near the ground through its influence on the boundary layer and the fast photochemistry, which defines anthropogenic ozone formation. Surface ozone measurements have been performed in Sofia, Bulgaria during the solar eclipses on 11 August 1999 and on 31 May 2003. The first data have been analyzed with respect to photochemical ozone production, but the second ones may be useful for understanding the evolution of the surface ozone in the growing (after sunrise) mixing layer.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Relative Timing of Nightside and Dayside Plasmasphere Erosion

Goldstein J.[1], Sandel B.R.[2], Wolf R.A.[3]

[1]Southwest Research Institute, Boston, MA 02215, USA

[2]University of Arizona, Tucson, AZ 85721-0092, USA

[3]Rice University, Houston, TX 77251-1892, USA

During geomagnetic disturbances the outer layers of the plasmasphere are removed and the outer boundary (the plasmapause) moves inward, a process known as erosion. It is generally accepted that erosion results from enhanced sunward convection during intervals of southward interplanetary magnetic field (IMF). Convection-based models of erosion predict that a global convection electric (E) field is imposed on the inner magnetosphere, producing plasmapause effects on both the nightside and the dayside. Enhanced sunward

convection is predicted to cause the nightside plasmapause to move inward, and the dayside plasmapause to move outward, creating a plume. Global plasmasphere images obtained by the IMAGE extreme ultraviolet (EUV) imager have verified the convection-model predictions, and have enabled studies of the timing of erosion. The timing of nightside plasmapause motion relative to IMF polarity changes at the magnetopause is one aspect of a more fundamental problem: what are the details of magnetospheric response to an IMF polarity transition? It is believed that the solar wind imposes a potential across the polar cap, and that this potential drives global magnetospheric convection. Though the relative timing of the dayside and nightside ionospheric response has been examined, the dayside-to-nightside plasmaspheric timing has not. Observationally, many details of how the inner magnetospheric E-field is imposed are not known, perhaps because of a paucity of global E-field measurements at low L. Most models have treated convection as a global quantit an increase in convection is felt throughout the inner magnetosphere, on both dayside and nightside. This paper examines the relative timing of dayside and nightside plasmapause motion following a southward IMF turning on 2 June 2001. We find that the dayside and nightside plasmapauses appear to respond simultaneously, although the determination of simultaneity is constrained by the 10 min cadence of EUV image data.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Sun-to-Earth Simulations with the Space Weather Modeling Framework

Gombosi T.I., **Tóth G.**, **Sokolov I.V.**, **De Zeeuw D.L.**, **Ridley A.J.**, **Manchester W.B.**

Center for Space Environment Modeling, University of Michigan, Ann Arbor, MI 48109, USA

SWMF is a fully functional and documented framework that provides a high-performance computational capability to simulate the physics from the low solar corona to the upper atmosphere of the Earth. The SWMF integrates interoperating models of physics domains, ranging from the surface of the Sun to the upper atmosphere of the Earth. Each region is described by a world-class model, and the coupled models result in a self-consistent whole. Presently the following modules are in SWMF: solar corona model (SC), eruptive event generator (EE), inner heliosphere model (IH), solar energetic particles model (SP), global magnetosphere model (GM), radiation belt model (RB), inner magnetosphere model (IM), upper atmosphere and ionosphere model (UA), and the ionospheric electrodynamics model (IE). SWMF and its physics modules are publicly available at http://csem.engin.umich.edu.

This talk will briefly summarize SWMF and describe some simulations carried out with SWMF and its physics models. We focus on the most violent time period of recent history, the Halloween storms. These storms represent a major computational challenge to any simulation tool. We demonstrate the capabilities of SWMF by successfully simulating this very challenging series of events.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Understanding the Variation of Magnetospheric Convection due to IMF Driving through Numerical Simulations

Goodrich Ch.

Center for Integrated Space Weather Modeling, Boston University, 25 Commonwealth Ave., Boston, MA 02213, USA

The response of the magnetosphere ranges from isolated substorms in the case of limited periods of modest southward IMF to large magnetic storms due to prolonged periods of strongly southward IMF. However the response of the magnetosphere to extended periods of moderately southward IMF remains unclear. For this moderate level of driving, the magnetosphere can exhibit either steady magnetospheric convection (SMC), in which a steady state balance of energy inflow and dissipation appears to be attained, or Sawtooth behavior, in which there are periodic injections of energetic particles into the inner magnetosphere. While we have identified these apparently different modes of the magnetosphere in individual events, we have yet to understand the differences in magnetospheric response responsible for the i.e., are Sawtooth events periodic substorms, are they and/or SMCs related to storm conditions, in which they are often observed.

Our understanding of the magnetospheric convection and the tail current sheet structure that supports is currently based on statistical surveys of spacecraft observations. How the convection and current sheet structure change for these different levels of solar wind driving remains only qualitatively understood. We explore here magnetosphere response through MHD simulation to this range of solar wind driving. The events include the Halloween storm (Oct 29–30) of 2002, which exhibited Sawtooth behavior late on Oct 29, the well studied Sawtooth period of April 18, 2002, the February 3, 1998 SMC event studied by the NSF GEM program, and the isolated substorm of August 11, 2002. We will focus on the structure and evolution of the current sheet and the plasma convection during these events in an attempt to provide a coherent picture of the magnetospheric response for increasing solar wind driving.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Solar Sources and Geospace Consequences of Interplanetary Magnetic Clouds

Gopalswamy N., **Akiyama S.**, **Yashiro S.**, **Michalek G.**, **Xie H.**, **Petty S.**, **Lepping R.P.**

NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

The interplanetary (IP) magnetic clouds (MCs) are a subset of coronal mass ejections (CMEs) observed in the solar wind. MCs are defined as the IP CMEs (ICMEs) with enhanced magnetic field, smooth rotation of the magnetic field and low plasma beta. It is possible that all CMEs are MCs, if the observer is suitably located. Therefore, a detailed study of the MCs may also help understand all CMEs. The flux-rope structure of MCs make them highly likely to be geoeffective because either the front or the back of the MCs are likely to contain magnetic field with a southward component (except for some high-inclination clouds). The solar and eliospheric observatory (SOHO) mission has detected a large number of CMEs over the entire solar cycle 23 and has provided an excellent opportunity to study the solar origin of MCs. We have utilized the SOHO CME data base to identify the CMEs that correspond to all the 85 MCs observed up to the end of 2003. We report the properties of the MCs and the associated CMEs. We also used the Dst index to assess the geoeffectiveness of the MCs by correlating the Dst index with the CME and MC properties. We find that the product of CME speed and magnetic field strength has the highest correlation with the Dst index. Finally, we compare the geoeffectiveness of the MCs with that of other ICMEs.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

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Solar MHD Discontinuities and the Dynamics of the Interplanetary Space

Grib S.A.

Academy of Sciences, Central Astronomical Observatory, Pulkovo, RU-196140 St. Petersburg, Russia

Different types of solar shock waves carring energy and changing the value of the interplanetary magnetic field are considered in the frame of the magnetohydrodynamics(MHD). Frontal and oblique interactions in the vicinity of the magnetic clouds and the terrestrial magnetosphere are described. It is shown that some types of the interactions may become a source of an abrupt appearance of the dissipation of plasma both in the solar corona and the magnetosphere of the Earth. By the way some interactions are strongly asymmetric and may be the source of so called dawn-dusk asymmetry near the magnetopause. An important correlation between the MHD theory and *in situ* experiment is underlined.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Spatial-Temporal Characteristics of Ion Acceleration Sites in the CS of the Earth's Magnetotail. Cluster Observations

Grigorenko E.E.[1], **Sauvaud J.-A.**[2], **Zelenyi L.M.**[1]

[1]Space Research Institute, RU-117997 Moscow, Russia

[2]CESR, PO Box 4346, F-31028 Toulouse Cedex 4, France

The processes of non-adiabatic ion acceleration occurring in the vicinity of magnetic X-line produce highly accelerated (up to 2500km/s) field-aligned ion beams (beamlets) with transient appearance streaming earthward in the PSBL of magnetotail. Previous studies of these phenomena based on the data from one-spacecraft missions supported a view on beamlets as of temporal transients, since the typical time of beamlet observation at a given spacecraft was $\sim$1–2 min. Now multipoint Cluster observations brought new understanding of these phenomena as having a rather spatial than temporal structure. Comparison of data from different Cluster spacecraft allows to evaluate the duration of beamlets to be, at least, 5-15 min and confirms their well-defined localization along Y (Z) directions, *i.e.* across the lobe magnetic field. Earlier results reporting shorter duration of beamlet observations could be understood by the invoking of an additional effect revealed by Cluster: earthward propagation of kink-like perturbations along the beamlet filaments. Phase velocity of these perturbations is of the order of the local Alfvén velocity ($V \sim$ 600–1000 km/s) and related fast flappings of localized beamlet structures in Y–Z direction significantly decreases the time of their observation at a given spacecraft. Such Alfvénic-type disturbances may be caused by classical fire-hose instability which develops at the moment of beamlet ejection from the CS to the lobe region of the distant magnetotail, where the lobe magnetic field is not too large and the conditions for a such pressure anisotropy instability could be satisfied.

✓ CLUSTER OBSERVATIONS AND THEORY: POSTER

An Overview of NASA's Living With a Star & IHY

Guhathakurta M.

NASA Headquarters, Earth-Sun System Division (DF), Science Mission Directorate, Washington, DC 20546-0001, USA

NASA's strategic goal for the Heliophysics Division is to understand and predict the causes of space weather by studying the Sun, the heliosphere and the planetary environments as a single connected system. To achieve the systems science of Space Weather, first, a much deeper understanding of the physical processes in the Sun and Solar System that produce destructive space weather is required than is presently available. Second, an integrated understanding of the coupled Sun-Solar System must be achieved. These advances require research that cuts across traditional discipline boundaries to deliver systems science. Furthermore, in order to be truly useful to life and societal goals of LWS this will require research that solves a problem in depth, from observation, to rigorous quantitative model, to useful prediction/specification. In order to address this space weather challenge, LWS initiated an interdisciplinary research program of space missions and Targeted Research and Technology (TR&T). The role of the TR&T program within LWS is to integrate scientific output, data, and models to generate a comprehensive, systems understanding of Sun–Heliosphere–Planets coupling. In order to succeed, the TR&T must tackle large-scale problems that cross discipline and technique (data analysis, theory, modeling, etc.) boundaries. Consequently, a new and innovative implementation plan for the program has been developed that incorporates two key elements: focused science topics and strategic capabilities. Another important aspect of LWS science is to better understand the connection between solar variability and its impact on climate.

In this talk I will try to summarize LWS and other important missions relevant to LWS science objectives and future plans for Targeted Research and Technology. The effects of solar activities and space weather phenomena on daily lives, environment, and space systems are becoming more apparent, and the need to collaborate and cooperate with the international community to reach a greater understanding of these consequences is urgent. To that effect I will provide an overview of one important international effort in this area namely, International Heliophysical Year.

✓ PLENARY LECTURES: ORAL

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Study of the Auroral 5577 Å and 6300 Å Emissions under Quiet and Disturbed Conditions

Guineva V.[1], **Trondsen E.**[2], **Marple S.**[3], **Hall C.M.**[4], **Cannon P.**[5], **Hansen T.L.**[4]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, Stara Zagora Department, PO Box 73, BG-6000 Stara Zagora, Bulgaria

[2]University of Oslo, Department of Physics, N-0316 Oslo, Norway

[3]Lancaster University, Department of Communications Systems, LA1 4WA Lancaster, UK

[4]Tromsø Geophysical Observatory, University of Tromsø, N-9037 Tromsø, Norway

[5]Radio Science and Propagation Group, QinetiQ, Hampshire GU14 0LX, UK

Measurements of the 5577 Å and 6300 Å emissions have been performed by All-Sky Imager (ASI), at Andøya Rocket Range (ARR), Andenes, Norway. The Norwegian island Andøya affords excellent opportunities for the Arctic atmosphere and ionosphere research thanks to its geographic position, and to the rich complex of instruments, installed and functioning in the Arctic Lidar Observatory for Middle Atmosphere Researche (ALOMAR) and ARR, as well. Auroral images, obtained by ground-based imaging systems, are a useful tool for investigating the physical processes responsible for auroral emission. Simultaneous All-sky camera data are used to watch the atmospheric conditions. Data during a quiet night (November 7, 2005, 15:30:00 UT - November 8, 2005, 5:50:00 UT) and at highly disturbed geomagnetic conditions (November 3, 2005, 15:50:00 UT - November 4, 2005, 5:40 UT) are used for the study. The emissions distributions in both cases are compared.

For better understanding of the auroral images and the arcs behaviour, resulting of a lot of phenomena, simultaneous data from other instruments are used together with solar activity, solar wind and IMF data. The activity in the energetic particle precipitation over a large area of the ionosphere is studied from the riometer beam data and absorption images, obtained using the measurements of the Imaging Riometer for Ionospheric Studies (IRIS) at and provided by the Lancaster University. The Tromsø digisonde ionograms give information about the plasma parameters. The course of the terrestrial magnetic field components, registered at Andenes station, and the geomagnetic activity are provided by the Tromsø Geophysical observatory. Solar wind and IMF data are used from the available Internet sites.

Analysis of the data is performed to look for the relations between the different processes and for their influence on the auroral arcs. The study is performed under a project, part from the ALOMAR eARI Project, EU's 6th Framework Programme, Andenes, Norway.

✓ OTHER RELATED TOPICS: POSTER

Lyman-Alpha Detector Designed for Rocket Measurements of the Direct Solar Radiation at 121.5 nm

Guineva V.[1], **Witt G.**[2], **Gumbel J.**[2], **Khaplanov M.**[2], **Hedin J.**[2], **Neichev S.**[3], **Bankov L.**[1], **Gramatikov P.**[3], **Tashev V.**[1], **Popov M.**[1], **Hauglund K.**[4], **Hansen G.**[4]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, Stara Zagora Department, PO Box 73, BG-6000 Stara Zagora, Bulgaria

[2]Atmospheric Physics Group at the Department of Meteorology, Stockholm University, S-106 91 Stockholm, Sweden

[3]Space Research Institute, Bulgarian Academy of Sciences, BG-1000 Sofia, Bulgaria

[4]Andøya Rocket Range, N-8483 Andenes, Norway

Rocket measurements of the direct Lyman-alpha radiation penetrating in the atmosphere were planned during the HotPay I rocket experiment, June 2006, Project ASLAF (Attenuation of the Solar Lyman-Alpha Flux), Andya Rocket Range (ARR), Norway. The basic goal of ASLAF project was the study of the processes in the summer mesosphere and thermosphere (up to 110 km), at high latitudes using the Lyman-alpha measurements.

The resonance transition 2P–2S of the atomic hydrogen (Lyman-alpha emission) is the strongest and most conspicuous feature in the solar EUV spectrum. Due to the favorable circumstance, that the Lyman-alpha wavelength (121.5 nm) coincides with a minimum of the O_2 absorption spectrum, the direct Lyman-alpha radiation penetrates well in the mesosphere. The Lyman-alpha radiation is the basic agent of the NO molecules ionization, thus generating the ionospheric D-layer, and of the water vapour photolysis, being one of the main H_2O loss processes.

The Lyman-alpha radiation transfer depends on the resonance scattering from the hydrogen atoms in the atmosphere and on the O_2 absorption. Since the Lyman-alpha extinction in the atmosphere is a measure for the column density of the oxygen molecules, the atmospheric temperature profile can be calculated thereof. The detector of solar Lyman-alpha radiation was manufactured in the Stara Zagora Department of the Solar-Terrestrial Influences Laboratory (STIL). Its basic part is an ionization camera, filled in with NO. A 60 V power supply is applied to the chamber. The produced photoelectric current from the sensor is fed to a 2 channels amplifier, providing analog signal.

The characteristics of the Lyman-alpha detector were studied. It passed successfully all tests and the results showed that the so-designed instrument could be used in rocket experiments to measure the Lyman-alpha flux.

From the measurements of the detector, the Lyman-alpha vertical profile can be obtained. The forthcoming scientific data analysis could include radiative transfer simulations, O_2 density, atmospheric power and temperature profiles retrieval as well as co-analysis with other parameters, measured near the polar summer mesopause and study of the processes in this region.

ASLAF project is a scientific cooperation between STIL-BAS, Stara Zagora Department and the Atmospheric Physics Group at the Department of Meteorology (MISU), Stockholm University, Sweden. The joint project is part of the rocket experiment HotPay I, in the ALOMAR eARI Project, EU's 6th Framework Programme, Andya Rocket Range, Andenes, Norway.

The project is partly financed by the Bulgarian Ministry of Science and Education.

✓ Other Related Topics: POSTER

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Modeling Magnetospheric Dynamics: Successes and Challenges

Hesse M.

CCMC, Code 612.3, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

In addition to the ionospheric research, magnetospheric science has made great strides toward the creation of models that extend beyond qualitative reproduction of observed dynamics. Owing to the efforts of a number of research groups, magnetospheric models have evolved to the point of reproducing, on a routine basis, major features of magnetospheric evolution quantitatively. Already at this time, this success provides new tools to space weather applications. Owing to the complexity of the magnetospheric system, however, a number of dynamical features are not yet described sufficiently well. This presentation will provide an overview of present magnetospheric modeling capabilities. In addition, we will analyze missing elements of magnetospheric dynamics, and their relation to agnetospheric complexity. We will provide an outlook into future improevements and we will suggest priorities based on scientific research and space weather operational needs.

✓ Sun–Earth System Modeling and Prediction: ORAL

A Study of the Relationship between Magnetic Clouds and the Heliospheric Current Sheet

Blanco J.J., **Hidalgo M.A.**, **Rodríguez-Pacheco J.**, **Sequeiros J.**

Space Research Group, Dpto. Física, Univ. Alcalá, Alcalá E-28871 de Henares-Madrid, Spain

The relationship between the Magnetic Clouds (MC) and the Heliospheric Current Sheet (HCS) is not completely understood. The presence of current sheets surrounding Magnetic Clouds have been widely observed. The main problem is to establish if the current is formed while the MC is travelling trough the solar wind or if it already existed when the CME was triggered at the Sun and therefore it is directly connected with structures in the solar corona. As a first step it is necessary to determine if the Current Sheets found close to MCs in the Interplanetary Medium are part of the same event, i.e. if the are closely related each other, or not. In order to analyze this problem we have selected the Magnetic Clouds that were accompanied by a neighbour current sheet during the period 1995-1997, corresponding to solar minimum conditions and detected by Magnetic Field Instrument on board Wind spacecraft. Once a HCS crossing is confirmed, we use our models for Magnetic Clouds and HCS local structure in order to establish the relative orientation between the Magnetic Cloud axis and the normal vector to the HCS plane. In our opinion, we can establish a relation between both phenomena if their orientations have similar values for all MCs analyzed. We present preliminary results on this work.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Long Dance of the Bashful Ballerina

Hiltula T., **Mursula K.**

Department of Physical Sciences, University of Oulu, PO Box 3000, FIN-90014 Oulu, Finland

We have shown that the heliospheric current sheet (HCS) is southward shifted or coned during the late declining to minimum phase of the solar cycle. This rule, called the bashful ballerina, was first found in the 40-year OMNI data set of the heliospheric magnetic field (HMF) observations at 1AU, and later verified by observations of the solar photospheric magnetic field for the last 30 years. This north-south asymmetry is due to a large scale solar quadrupole field synchronized with the oppositely oriented solar dipolar field. We have extended the study of the north-south asymmetry of the HCS using a recent data set of HMF sector polarities extracted from ground-based magnetic observations. The HCS was found to be similarly southward shifted during the late declining to minimum phase of the solar cycle in the early part of the studied data interval (1926–1955). Accordingly, the solar ballerina has been bashful at least during the last 80 years. Solar cycle 19 presents a period of a very curious behaviour for the HCS with an exceptionally large HMF toward sector dominance in 1957, the year of cycle 19 maximum, and an equally strong away sector dominance in 1960, the time of final solar polarity reversal.

Here we compare the recent HMF data set to other HMF data sets derived from the geomagnetic measurements and discuss the differences of these data sets. We also discuss the possibilities and means to further extend the HCS study in the past.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Electron Acceleration by Whistler Mode Chorus Waves in the Earth's Radiation Belts During Magnetic Storms

Horne R.B.[1], **Meredith N.P.**[1], **Glauert S.A.**[1], **Boscher D.**[2], **Varotsou A.**[2], **Thorne R.M.**[3], **Anderson R.R.**[4]

[1]British Antarctic Survey, Cambridge CB3 0ET, UK

[2]ONERA, F-31055 Toulouse Cedex 4, France

[3]UCLA, Los Angeles, CA 90095-1547, USA

[4]University of Iowa, Iowa City, IA 52242-1419, USA

About 50% of geomagnetic storms result in a net increase in the relativistic electron flux in the outer radiation belt. About 20% of storms result in a net decrease. Understanding the processes responsible for the flux variations is a major problem in magnetospheric physics. Here we use quasi-linear theory to show that electron acceleration by whistler mode chorus waves is most efficient in low-density regions, and is responsible for electron flux increases observed during very large magnetic storms on a timescale of 1–2 days. We present a method of incorporating wave acceleration into a global radiation belt model so that electron transport, acceleration and loss can modelled during storms. We present simulations for different types of magnetic storms and show that wave acceleration can be very effective throughout the outer radiation belt. We show that storms with a long recovery phase, such as those associated with corotating interaction regions and fast solar wind streams, provide sustained supply of electrons towards lower L shells which

continually enhances chorus wave activity and thereby produces effective electron acceleration. We discuss the conditions for effective wave acceleration and use this to suggest why some storms are more effective than others in producing increases in radiation belt electron fluxes.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

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Whistler-mode Chorus: CLUSTER Observations and Implications for Triggered VLF Emissions

Inan U.S.

Space, Telecommunications and Radioscience (STAR) Laboratory; Stanford University, Stanford, CA 94305-9515, USA

Recent observations of discrete whistler-mode chorus emissions on the CLUSTER spacecraft provides the first glimpse of the spatial extent and the rapid motions of the source regions of these most intense electromagnetic emissions in the Earth's magnetosphere. The new observations raise interesting new questions concerning the generation mechanisms of chorus, since present models do not include the motion of the source as an inherent part of the interaction, and are also typically limited to one or two dimensions, without accounting the compact nature of the source. In view of the remarkable similarity (*e.g.*, in terms of coherence, disceret nature, and spectral shapes) between spontaneously generated chorus emissions and VLF triggered emissions (triggered in an otherwise apparently stable plasma by the injection of a very weak coherent external signal), the new CLUSTER observations of chorus also suggest that the source mechanisms for such triggered emissions may also be compact and in rapid motion. VLF triggered emissions are a remarkably nonlinear phenomena that has been extensively investigated in controlled wave-injection experiments, but their physical interpretation has so far defied any attempts of computer simulation. In this paper, we review the CLUSTER observations, and contrast them with data on triggered emissions, with the point of view of bringing out the features of these highly coherent plasma phenomena that now deserve new attention in terms of theoretical and computer simulation work.

✓ CLUSTER OBSERVATIONS AND THEORY: ORAL

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Fractal Properties of Magnetic Fields of Active and Quiet Solar Regions

Chertoprud V., **Ioshpa B.**, **Obridko V.N.**

Solar-Terrestrial Physics Division of IZMIRAN, RU-142190 Troitsk, Russia

We discuss some results of the study of spatial characteristics of solar magnetic fields. The analysis is based on the magnetic field data obtained with a new spectromagnetograph installed on the IZMIRAN Tower Telescope (FeI 6103 A), the data of the MSFC solar vector magnetograph (FeI 5250.2 A) and the data of longitudinal magnetic 96 m daily maps of SOHO/MDI magnetograph (NiI 6768 A) downloaded through Internet. Our study was directed in three ways: the fractal properties of sunspots; fractal properties of the space distribution of the magnetic fields along great distances comparable with the size of great active regions or active complexes; fractal properties of active and quiet magnetic regions as global entities. To investigate the fractal structure of the sunspots we used the well known method of calculating a fractal dimension using the relation between the area and the perimeter of magnetic field contours; for analysis of fractal properties of the space magnetic field distribution on the solar surface the technique developed by Higuchi (who applied it to the investigation of long time series) was used.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Influence of the Solar Geoeffective Phenomena on a Climate of the Earth's Environment Space

Ishkov V.

Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagations, Russian Academy of Sciences,
RU-142190 Troitsk, Russia

Researches of last 30 years have allowed to allocate confidently the solar phenomena which influence space weather in environment. It first flare phenomena solar flares and solar filament eruptions) and second solar coronal holes. Disturbances from solar flare phenomena, being propagated in the solar corona, form observable coronal mass ejection under which characteristics it is possible with a sufficient degree of confidence to predict a condition of Earth's environment. High-speed streams of a solar wind from solar coronal holes are responsible for recurrent disturbances of a geomagnetic field and increase of high energies electrons fluxes, influencing on radiating conditions in Earth's environment. The beginning of an epoch of development of a space has fallen to the period of high solar cycles (19–22) when the level flare activity was much higher than the last 100 years, and, probably, the next 100 years. It means, that the

background characteristics determining a space climate in a heliosphere and, in particular, in a Earth's environment space, during low and moderate solar cycles should be reconsidered. Decrease spots activity of the Sun should lead to sharp reduction of quantity of the geoeffective solar phenomena, responsibility for sporadic, the strongest, disturbances of a environment. At the same time the quantity of weaker recurrent events should significant grow. Comparison of the large flare events effect in low and moderate cycles of solar activity (16, 17, 23) with high (18, 19, 21, 22) is carried out.

✓ Solar Cycle Variations in the Sun–Earth System: POSTER

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Quasi-Biennial Oscillations of the Total Sunspot Areas in the Active Longitude Sectors

Ivanov E.V.

IZMIRAN, RU-142190 Troitsk, Russia

The data from the Greenwich Observatory for 1879–2004 (cycles 12–23) have been used to plot a time (Carrington rotations) *vs.* Carrington longitude diagram of distribution of the rotation-summed daily areas for each sunspot group (SCR) separately in the North and South hemispheres. The behavior of the active longitude zones (their location, shift, and intensity variations) identified on these diagrams has been analyzed over the entire time interval under consideration. The quasi-biennial oscillations (QBO) of the total sunspot areas in the sectors of heliolongitudes corresponding to four active longitude zones separately in the North and South hemispheres have been studied using the spectral and correlation analyses for the period from 1879 to 2004. The relationship between the antipodal, symmetric with respect to the equator, and adjoining active longitude zones have been analyzed. Probable scheme of the active longitude formation is suggested.

✓ Solar Cycle Variations in the Sun–Earth System: POSTER

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On the Character of Rotation of Active Longitudes

Ivanov E.V.

IZMIRAN, RU-142190 Troitsk, Russia

The Greenwich data for 1879–2005 (cycles 12–23) have been used to study the heliolongitude distribution of the sunspot group areas summed over a Carrington rotation (SCR) separately in the South and North hemispheres. The active longitude (AL) zones have been identified and their behavior (location, shift, and intensity variations) has been analyzed over the entire time interval under consideration. It was obtained, that the AL zones consist of a set of individual narrow sunspot formation zones, which rotate rigidly with a Carrington period $T \sim 27.3$ days. The lifetime of the sunspot formation zones exceeds significantly the lifetimes of individual sunspots and may reach 15-20 rotations. The analysis of the rotation characteristics of the sunspot formation zones in the reference frames associated with the synodic rotation periods ranging from 25 to 29 days has revealed three principal rotation periods of active longitudes: ~ 27.1–27.3, 26.8–26.9, and 27.6–27.8 days. The last two periods are determined by the migration of the occurrence sites of the sunspot formation zones. An attempt is made to explain the contradictory data on the character of rotation of active longitudes.

✓ Solar Cycle Variations in the Sun–Earth System: POSTER

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Anisotropy and Magnetic Quenching in Slightly Stratified Magnetoconvection Model

Ivanovski S., **Ruediger G.**, **Giesecke A.**

Astrophysikalisches Institut Potsdam, An der Sternwarte 16, D-14482 Potsdam, Germany

In order to model the magnetoconvection in sunspots the transition from 3D to 2D turbulence under the influence of strong magnetic fields is simulated. The idea is that the vertical magnetic field of sunspots produces highly anisotropic types of turbulence with strong suppression of the vertical turbulence intensity and a distinct increase of the correlation length along the field direction. For strong fields the turbulence energy parallel to the magnetic field exceeds the energy perpendicular to the field by a factor of two. Numerical simulations with the NIRVANA code [Ziegler, 1999] for magnetoconvection lead to similar results. The simulations are done in a box heated from below under the presence of a weak density stratification. The magnetic background field is orientated in vertical direction. We find that the magnetic field makes the MHD turbulence highly anisotropic. The magnetic q-quenching is stronger than that of the turbulent intensities.

✓ Other Related Topics: POSTER

MHD Instabilities in the Magnetopause Layer

Ivanovski S., **Kartalev M.**, **Vatkova G.**

Institute of Mechanics, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

We report further development of the earlier proposed numerical scheme for simulating a coupled Kelvin–Helmholtz and tearing mode instabilities in a simplified model of magnetopause layer. Time-dependent two-dimensional MHD approach is utilized for incompressible viscous and conductive flow. An attempt is made for more realistic simulation of the magnetopause mixing layer: the axes of the sharp changes of gasdynamic and electromagnetic parameters are supposed to be shifted. It seems that this approach permits more realistic interpretation of the transient events, registered by ground-based magnetometers. This concerns especially the velocity of the observed phenomena.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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3D Evolution of 'Density-Driven' CME Events

Jacobs C., **Poedts S.**, **van der Holst B.**

Centrum voor Plasma-Astrofysica, K.U. Leuven, Celestijnenlaan 200B, B-3001 Leuven, Belgium

High speed solar Coronal Mass Ejections (CMEs) are observed to cause deflections of helmet streamers in the lower solar corona and strong, complex magnetohydrodynamic (MHD) shock waves in the interplanetary (IP) space. In these IP shock waves energetic particles are continuously accelerated giving rise to gradual solar energetic particle events (SEPs). As a result, CMEs and CME generated shock waves play a key role in the so-called space weather. The long-term ($>$ 1 day) predictions of the different space weather phenomena are currently not very accurate due to the lack of insight in the basic physics and the physics of the solar drivers of space weather. Therefore, better mathematical models of the fast CMEs are required.

We present results of numerical simulations based on such models of the initiation and the IP evolution of CMEs in the framework of ideal MHD. As a first step, the magnetic field in the lower corona and the background solar wind are reconstructed. Both simple, axi-symmetric (2.5D) solar wind models are constructed for the quite Sun and more complicated 3D solar wind models taking into account the coronal field (potential field approach taking into account the photospheric magnetic flux) for the active phase of the Sun. In a second step, fast CME-events are mimicked by superposing high-density plasma blobs on the background solar wind and launching them in a given direction at a certain speed. In this way, the CME-streamer interactions are studied and also the effect of a CME event on the coronal magnetic field.

✓ SUN-EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Can a Dawn-Dusk Asymmetry in Plasma Heating and Transport at the Magnetopause be Explained by Nonlinear Interactions with ULF Waves?

Johnson J.R.[1], **Wing S.**[2], **Lin Y.**[3]

[1]Princeton University, Plasma Physics Laboratory, PO Box 451, Ms#28, Princeton, NJ 08543, USA

[2]The Johns Hopkins University, Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, USA

[3]Auburn University, Department of Physics, 206 Allison Laboratory, Auburn, AL 36849, USA

The magnetopause and boundary layer are typically characterized by large amplitude transverse ULF wave activity with frequencies below the ion cyclotron frequency. The wave properties are consistent with a mode conversion process that couples large-scale surface MHD fluctuations with kinetic Alfvén waves at the magnetopause boundary. We model the waves with theory and global three-dimensional hybrid simulations. We find that ions and electrons can interact nonlinearly with these waves leading to perpendicular heating of ions, parallel heating of electrons, and plasma transport across the magnetopause boundary. We compare these theoretical findings with both in situ GEOTAIL particle observations and remote observations of plasma along the magnetotail flanks inferred using DMSP. We discuss the time scale for the filling of the plasma sheet as well as possible causes for dawn-dusk asymmetries in the particle distributions that are manifest in the global density and temperature profiles.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

A Solar Cycle Dependence of Nonlinearity in Magnetospheric Activity

Johnson J.R.[1], **Wing S.**[2]

[1]Princeton University, Plasma Physics Laboratory, PO Box 451, Ms#28, Princeton, NJ 08543, USA

[2]The Johns Hopkins University, Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, USA

We examine nonlinear dependencies in the historical data stream of the Kp index from 1932 to present. We find that the dynamics of the magnetosphere tend to be more linear at solar maximum than at solar minimum. The strong nonlinear dependencies tend to peak on a timescale around 40–50 hours and are statistically significant up to one week. Because the solar wind driver variables, VBs and dynamical pressure exhibit a much shorter decorrelation time for nonlinearities the results seem to indicate that the nonlinearity is related to internal magnetospheric dynamics. Moreover, the timescales for the nonlinearity seem to be on the same order as that for storm/ring current transport. In the descending phase of the solar cycle just prior to solar minimum, when magnetospheric activity is weaker, the dynamics exhibit a significant nonlinear internal magnetospheric response that appears to be related to increased solar wind speed. To investigate this effect further, we analyzed nonlinear dependencies during 1995–1996 when a series of high speed stream interfaces were detected in the solar wind, and we discuss the physical origin of the nonlinear response.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Acceleration and Transport of Energetic Particles Observed in the Inner Heliosphere

Jokipii J.R.

University of Arizona, Tucson, AZ 85721-0092, USA

Several distinct species of energetic particles – ranging from those accelerated at the Sun, shocks and co-rotating interaction regions to galactic and anomalous cosmic rays – are observed in the inner heliosphere.

A number of different acceleration mechanisms – stochastic waves, shocks and more-gradual compressions – have been proposed to explain the observations and each mechanism has its adherents. The various mechanisms will be introduced, and the differences between statistical acceleration and acceleration at shocks at quasi-perpendicular and quasi-parallel shocks and compressions will be discussed.

Spatial transport is an important part of the acceleration process, and the accelerated particles must usually propagate through the turbulent solar wind to the point of observation. Both the acceleration and the subsequent transport of the particles depend fundamentally on the nature of the ambient, generally turbulent, plasma and electromagnetic fields.

The basic physics of this acceleration and transport and the constraints imposed by recent in situ and remote observations of the energetic particles in the inner heliosphere will be discussed.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Modeling Ring Current Dynamics and EMIC Waves Excitation

Jordanova V.K.

Space Science and Applications, Los Alamos National Laboratory, Los Alamos, NM 87545, USA

The ring current is an indicator of the flow of mass and energy through the near-Earth magnetosphere. Ring current ion composition varies significantly, with H^+ being the dominant ring current ion species during quiet times, and O^+ contributing mostly during active times. The anisotropic ring current populations generate plasma waves which could subsequently accelerate and/or scatter radiation belt particles. The generation and propagation characteristics of the electromagnetic ion cyclotron (EMIC) waves depend strongly on the presence of both cold and energetic heavy ions (mainly He^+ and O^+) in the plasmas. In this study we use our global physics-based model, which solves the relativistic kinetic equation for H^+, O^+, and He^+ ions and electrons. The model is coupled with a time-dependent plasmasphere model through the employed electric and magnetic fields. Time-dependent plasma inflow from the magnetotail, both convective and diffusive transport, and losses due to collisions, dayside outflow, and wave-particle interactions in a multi-component plasma are included. We simulate the sunward transport and acceleration of these particles during several geomagnetic storms and discuss ring current morphology, ion composition, and loss mechanisms during various storm phases. We calculate the excitation of EMIC waves as the storms progress and find that the regions of maximum EMIC wave growth are usually located near the plasmapause, however with quite variable magnetic local time dependence. Pitch angle scattering by these waves cause significant particle precipitation into the atmosphere and generation of detached subauroral arcs.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Storm-Time Ring and Tail Current Dynamics under Extremely Disturbed Conditions

Kalegaev V.V., **Makarenkov E.V.**

Skobeltsyn Institute of Nuclear Physics, Moscow State University, RU-119992 Moscow, Russia

Relative ring current and tail current contributions to Dst are investigated on the base of the statistical study of 70 magnetic storms of different intensities. Variations of the magnetic field produced by magnetospheric currents were calculated by paraboloid model of the magnetosphere taking into account effect of the Earth's induced currents. The quiet level magnetic field was calculated for each magnetic storm (using data of quietest days from WDC-2, Kyoto) and subtracted from magnetic field variation produced by each magnetospheric current system. The analysis of Dst sources demonstrates saturation of the tail current effect under extremely disturbed conditions. The ring current becomes dominant Dst source during severe magnetic storms, but during moderate storms its contribution to Dst is comparable with tail current's contribution. The ring current injection amplitude increases with the growth of magnetospheric disturbance level.

✓ Solar Dynamics and the Response of Geospace: POSTER

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Two New Tools for Sun–Earth System Modeling: Global Kinetic Simulations and Machine Learning Techniques

Karimabadi H.[1,2]

[1]SciberQuest, Inc., Solana Beach, CA 92075, USA

[2]Department of Electrical and Computer Engineering, UCSD, La Jolla, CA 92093, USA

A variety of processes have been proposed to explain the transfer of solar wind mass and momentum into the magnetosphere. The relative importance of these mechanisms and their dependence on the IMF are still under debate. Furthermore, many basic issues such as the origin of plasma sheet remain poorly understood. The collisionless nature of the space plasmas necessitates a kinetic treatment to develop a full understanding of these transfer processes.

In this talk, we describe two new tools that we are developing for study of Sun–Earth system. The first is a 3D global hybrid code. We will provide an overview of (i) the advanced numerical techniques utilized including self-adapting simulations, (ii) demonstration of some of the new physics that can be obtained illustrated by several examples, (iii) comparison with global MHD, (iv), and effect of resistivity on the solutions.

The second set of tools is advanced data mining techniques with reverse engineering capability. By reverse engineering we mean that the outcome of the algorithm (*i.e.*, the predicted model) is an analytical function with proper dependencies on the input parameters rather than say a set of neural net connection as in artificial neural net. We illustrate the power of these techniques using examples in (i) pattern recognition (*e.g.*, detection of magnetospheric boundaries), (ii) modeling (*e.g.*, shape of the magnetopause), and (iii) dependency studies (*e.g.*, determining the controlling quantities that trigger an event such as FTEs).

✓ Sun–Earth System Modeling and Prediction: ORAL

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Comprehensive Investigation of the Upper Ionosphere Response to the Solar Wind Impact on March 22-23, 1979

Karpachev A.T.

IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

The global response of the upper ionosphere to the strong magnetospheric storm on March 22–23, 1979 is investigated. Data of the Cosmos-900 and Intercosmos-19 satellites and ground-based sounding, as well as the results of previous investigations, have been used. The global background distributions of N_e and T_e at heights of 420–450 km were constructed from the Cosmos-900 data. On the basis of exact knowledge of background distribution, the storm-time variations in N_e and T_e on March 22–23, 1979, magnetic storm were revealed. The main features of this response were found and investigated. The pattern of the global response of the ionosphere includes the variations in the ionospheric structure (the dayside cusp, nighttime auroral oval, ionospheric troughs, and equatorial anomaly) and the related variations in hmF2, NmF2, N_e, and T_e in the upper ionosphere.

The dynamics of the auroral and subauroral ionosphere has been studied based on simultaneous observations on the Cosmos-900 and Intercosmos-19 satellites. Variations in the positions of the equatorial boundaries of the dayside cusp and the nighttime auroral oval, auroral electrojet, minimum of the main ionospheric trough (MIT) and ring ionospheric trough (RIT), as well as of the related T_e peaks, have been studied in detail.

The dependence of the ionospheric response on local time at different latitudes has been distinguished. The negative and positive phases of the ionospheric storm were thoroughly examined. The planetary effects of internal gravity waves, IGWs, have been investigated in

detail. It has been established that the AGW effects in the ionosphere in terms of both universal and local time was determined by the pattern of high-latitude atmospheric heating, and that the wave front of the AGW during both substorms covered practically all local times, *i.e.*, all longitudes. One of the sources of the AGW was the thermospheric heating in the dayside cusp region. The AGW effects were clearly separated from the electric field effects related to the turnings of IMF B_z.

At the storm recovery phase the ring ionospheric trough, RIT, equatorward of MIT formed. The strong negative disturbance in N_e at invariant latitudes near 56–57° in the night-time ionosphere is associated with the deep RIT. The pronounced high-latitude trough formed even in the afternoon at latitudes near 700 equatorward of the day-side cusp.

The equatorial ionosphere variations are investigated. The equatorial anomaly both in the night-time and day-time during the main and recovery phases of the storm was depressed: its crests were decreased and shifted to the equator, and N_e and T_e over the magnetic equator were increased. The development and depression of the equatorial anomaly is associated with the effects of the electric field both of the magnetospheric and ionospheric origin.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

On the Model Explanation of the Observed Parameter Variations along Magnetosheath Satellite Trajectory

Kartalev M.[1], **Dobreva P.**[1], **Zastenker G.**[2], **Shevyrev N.N.**[2], **Amata E.**[3], **Savin S.**[2]

[1]Institute of Mechanics, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Space Research Institute, RAS, RU-117997 Moscow, Russia

[3]Istituto di Fisica dello Spazio Interplanetario C.N.R., I-00133 Roma, Italy

We report on a comparison of some plasma measurements of satellite instruments during magnetosheath crossings with model predicted variations along the same trajectories. We utilize a new self-consistent model of the system maghetosheath - magnetosphere, comprising 3D gasdynamic magnetosheat solver and modified data based magnetospheric magnetic field model with numerically calculated magnetopause shielding field. The magnetopause and shock wave shapes and positions are obtained self-consistently as a part of the solution. Thus the predicted parameters' distributions are supposed to be in realistic spatial scales which makes it a suitable tool for data interpretations along a single orbit line. We discuss different possible origins of large scale parameters' variation along the orbit: variations of the parameters of the solar wind flow, variations in the effective polytropic index of the solar wind plasma, irregularities, originated by 3D geometric asymmetries of the magnetosheath flow, which may be created in particular by tilt of the magnetic field dipole. We make use of some real Intelball 1 and Cluster magnetosheath crossings in order to demonstrate possible simple model explanation of some "strange" parameters' variations along the trajectory.

✓ CLUSTER OBSERVATIONS AND THEORY: ORAL

Magnetosphere Drivers of the Global Ionospheric Potential Distribution

Kartalev M.[1], **Liemohn M.W.**[2], **Keremidarska V.**[1], **Papitashvili V.**[2]

[1]Institute of Mechanics, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]University of Michigan, Ann Arbor, MI 48109, USA

We utilize a new numerical model of the global ionospheric electric potential distribution. The 2D spherical thin shell approach used in this model is obtained reducing the 3D approach of the electrodynamics problem, posed in coordinate system, aligned with the geomagnetic field and based on a realistic global conductivities distributions. The model comprises the global computational region, which includes both conjugate ionospheres as separate sub-domains. Field-aligned currents between magnetically conjugate points (with not necessarily equal potentials) are permitted. The special role of the equatorial ionosphere is obtained as a part of the global model. Consideration of different driving sources of the ionospheric potential distribution is possible. The study is restricted here on some estimates of the influences of the both polar regions field aligned current systems and ring current system. A numerical modeling of a real two-phase decay storm with starting point 00:00 UT on 24 September 1998 is applied in order to simulate the evolution of the global ionospheric electric potential distribution.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Role of Solar Flares and CMEs in Causing Geomagnetic Storms during Solar Cycle 23rd

Kaur S., **Kumar S.**

Department of Physics and Electronics, Rani Durgawati University, Jabalpur 482001, India

The study of H_α, X-ray solar flares and Coronal Mass Ejections (CMEs) and their effect on Geomagnetic Storms (GMSs) during the period July 1996 to Jan 2005 have been investigated. It is observed that maximum numbers of GMSs are associated with CMEs followed by individual H_α and X-ray solar flare events. However, when the accumulated effect of H_α and X-ray solar flare events are considered, in that case, these solar flares become more dominant than CMEs to cause GMSs. There is strong N–S asymmetry for solar cycle 23rd. An overall northern bias apparently prevailed for solar flares. H_α and X-ray solar flares occurring over the western limb of the solar disk cause larger disturbances in magnetosphere leading to occurrence of Intense GMSs whereas those solar flares which occur on the eastern limb of the solar disk lead to occurrence of Major and Minor GMSs. Linear fit speed for CMEs is largest causing the Intense GMSs followed by Major and Minor GMSs.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Coronal Intensities and Its Geoeffectiveness during 1996-2004

Kaur S., **Kumar S.**

Department of Physics and Electronics, Rani Durgawati University, Jabalpur 482001, India

The statistical study of Coronal Intensities (CIs) which are given in the millionths of intensity of the solar disk (coronal units) and its effect on geomagnetic storms (GMSs) during the period from July 1996 to Jan 2004 of the current solar cycle 23 have been investigated. It is observed that the CIs streaming towards the earth and triggering the large number of Minor GMSs (-20 nT $> Dst \geqslant -50$ nT) followed by Major GMSs (-50 nT $> Dst \geqslant -100$ nT) and Intense GMSs ($Dst < -100$ nT). It is also observed that CIs are more scattered for Major GMSs followed by Minor GMSs and Intense GMSs. The observation shows that the CIs found to posses an excellent correlation with occurrence of GMSs. It is observed that during the year of maximum solar activity, *i.e.*, 2000 CIs had peak for Minor GMSs whereas, during the following year 2001, CIs had peak for Intense and Minor GMSs. The results shows that the product of CIs with Dst, *i.e.*, (CIsDst) is the reliable predictor of the intensity of the GMSs.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Solar Wind Parameters Behavior before Magnetic Storms

Khabarova O.V., **Yermolaev Yu.I.**

Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

Search for geoeffective solar wind parameters is a key for successful building of magnetic storm prognosis. More weak point of predictive-directed investigations in this area is their orientation on revealing of origin of severe storms only. Most of prognosis techniques are based on detecting of geoeffective structures (like MCs), leading to severe storms commencement. But storms with $Dst \leqslant 100$ nT are very rare, and, as it was shown recently, moderate storms produce spacecraft fails and stress biosphere reaction more often, than storms of high intensities.

So, it is important to know, which solar wind structures are mainly geoeffective for whole body of magnetic storms and which typical conditions in solar wind precede magnetic storms.

We built the list of all storm‘s main phase beginnings for 1976–2000 and used OMNI2 data. The comparing of pre-storm distributions of solar wind parameters with whole data distributions showed that solar wind behavior before magnetic storms is mainly different from usual. We revealed, that some pre-storm solar wind changes (like solar wind density increase and velocity decrease 2–3 days before storm main phase) are observed in overwhelming majority of cases. Received results are confirmed by analogous test of list of magnetic storms with sudden commencements (SSC) for 40 years. The features of solar wind parameters changes before magnetic storms and nature of observed effects will be discussed in the report.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Polarization Jet Formation at the Substorm Expansion Phase Observed by Yakutsk and Podkamennaya Tunguska Stations

Khalipov V.L.[1], **Stepanov A.E.**[2], **Bondar E.D.**[2]

[1]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

[2]Yu.G. Shafer Institute of Cosmophysical Research and Aeronomy, RU-677980 Yakutsk, Russia

The polarization jet (PJ) features measured at two spaced stations Yakutsk ($L = 3.0$, $\lambda = 129.6^\circ$ E) and Podkamennaya Tunguska ($L = 3.0$, $\lambda = 90.0^\circ$ E) for the years 1989–1992 are considered. The data of these stations confirmed the earlier obtained result of PJ formation at the substorm expansion phase in premidnight sector during geomagnetic disturbances. Under isolated magnetic disturbances with $A_\mathrm{E} > 500$ nT within the interval of 11.00–16.00 UT, the PJ band covers the sector of 3 MLT hours between Yakutsk and Podkamennaya Tunguska. The PJ registration time at the Podkamennaya Tunguska station in most cases is delayed by 45–60 minutes in comparison to a moment of PJ appearance at the Yakutsk station. This suggests that PJ source moves from the east to the west with the velocity of ~ 3 hours of MLT per hour. This work was partially supported by RFBI Grant 04-02-16666.

✓ Solar Dynamics and the Response of Geospace: POSTER

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Long-Term and Short-Term Relation between Solar Activity and Atmospheric Circulation

Kirov B., **Georgieva K.**

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

After more than 200 years of investigations, the problem of solar activity influences on weather is still controversial. A number of possible mechanisms have been proposed, however none of them explains the instability of the correlation between solar activity and different meteorological parameters. Our previous studies have demonstrated that the sign of the correlation between solar activity as expressed by the sunspot number and the terrestrial climate as expressed by the surface air temperature in the 11-year sunspot cycle changes in consecutive secular solar cycles, and is determined by the North–South asymmetry of solar activity - positive when the northern solar hemisphere is more active and negative when more active is the southern solar hemisphere. Temperature anomalies are related to atmospheric circulationthe system of atmospheric motions over the Earth on the scale of the whole globe (general atmospheric circulation), or over a certain region with its specific features (local circulation). Here we study the response of the large-scale atmospheric circulation to solar activity depending on solar activity asymmetry on a secular time-scale, and the short-term response of atmospheric circulation to different solar drivers. We use the reconstruction of northern annular mode index as a proxy for the zonality of atmospheric circulation and find that in the XIX century when the southern solar hemisphere was more active, zonal circulation prevailed, while meridional circulation prevailed in the XX century when more active was the northern solar hemisphere. On a day-to-day time scale, superposed method analysis reveals that different solar drivers have different effect on circulation: high speed solar wind from coronal holes increases zonal circulation, and coronal mass ejections increase meridional circulation.

✓ Production, Transport, and Loss of Energetic Particles: POSTER

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The Role of Drifts of Galactic Electrons in the Heliosphere – Theoretical Calculations

Kobylinski Z.

University of Humanities and Economics, Faculty of Economics and Computer Science, PL-87 800 Wloclawek, Poland

The steady state 3D transport equation of galactic cosmic rays (GCR) with drift included is numerically solved in the cases of the classic Parker pattern, modified Parker heliospheric magnetic filed and the Fisk's type of magnetic field in the spherically symmetric heliosphere bounded at the distance of 100 AU. In the calculations the parallel and perpendicular diffusion coefficients are proportional to $1/B$, anti-symmetric element of the diffusion tensor has the form derived by Forman et al. under the assumption of week-scattering. At high latitudes where Fisk field would be weak the isotropic diffusion is assumed, other regions of the heliosphere is filled up by Fisk field. We assume also that two circular coronal holes are localized near the poles with the central points that are offset from the rotation axis by the angle of 10 degrees. The computed distributions of galactic electron density, gradients and modulated spectra are presented The calculated spectra are compared with experimental data.It is shown that the drift effects in the Fisk model should play an important role in the modulation, similar to the drift significance in Parker standard field and on the contrary to modifications of this model proposed by Jokipii and Kota and Smith and Bieber.

✓ Solar Cycle Variations in the Sun–Earth System: POSTER

Enhanced Plasma Fluxes in the Magnetospheric Midtail Lobes

Koleva R.[1], **Sauvaud J.-A.**[2], **Fedorov A.**[2], **Smirnov V.**[3]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Centre d'Etude Spatiale des Rayonnements, F-31028 Toulouse Cedex 4, France

[3]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

We use data from the ion and electron spectrometers aboard the INTERBALL Tail Probe satellite (IB-1) to study the characteristics of the enhanced plasma fluxes in the Earth magnetospheric midtail lobes, at X_{gsm} distances between -27 Re and -10 Re. As the magnetotail lobes are magnetically connected with the polar cap, we separated the observations according substorm activity and analyse representative cases. In the lobe regions with enhanced electron populations several morphologically different plasma regimes could be observed, during all geomagnetic conditions, but with different intensity and occurrence: 1) Small-scale (typically observed for several to 20 min) structures of electrons and ions with plasma sheet characteristics. 2) Structures similar in duration, but with characteristics typical for the boundary layers. The electron fluxes are field aligned and counterstreaming, the ions exhibit preferential flow directions, either tailward or sunward. 3) Large-scale regions of enhanced electrons with energies up to 200 eV and current density insufficient to produce any diamagnetic effect. The fluxes are field aligned but not balanced; the flows are intensified during geomagnetically disturbed periods. Usually ions are missing, however there are several cases when ions with energies up to 100 or 200 eV are present, tailward flowing, so lack of ions could be due to the high spacecraft potential. These regions are observed during several hours, IB-1 typically encounters one structure over distance up to 10 Re in X, 2–3 Re in Y_{gsm} and ~ 0.5–1.5 Re in Z_{gsm} directions. We focus on the characteristics of structures type (3) and discuss their possible origin.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

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Empirical Modeling of Earth's Outer Radiation Belt

Kondrashov D., **Shprits Y.**, **Ghil M.**, **Thorne R.M.**

UCLA, Los Angeles, CA 90095-1567, USA

Intense interest currently exists in developing dynamical empirical parameterizations of radiation belts. We present application of a novel empirical mode reduction (EMR) methodology for constructing a hierarchy of stochastically forced radiation belt empirical models. It is based on multiple polynomial regression to estimate deterministic propagator from the data and multi-level modeling of the stochastic forcing. This methodology encompasses both linear and nonlinear time-dependent models that aim to best describe the data set's statistics, and has been successfully applied before for ocean and atmosphere data sets.

Here we apply this methodology to study acceleration of relativistic electrons during magnetic storms in the Earth's outer radiation belt. As a starting point, we consider a data set of 1 MeV electron fluxes from integration of a radial diffusion model coupled to geomagnetic Kp index. The data are projected onto leading empirical orthogonal functions (EOFs) which provide an optimal predictor set. With these predictors, our best reduced stochastic model forced by Kp time series, produces excellent fit to the statistics of underlying data set, as well as reproduces very well magnetic storms observed in the full model's integration.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Optimal Estimation of Electron Lifetimes in the Outer Radiation Belt

Kondrashov D.[1], **Shprits Y.**[1], **Ghil M.**[1], **Thorne R.**[1], **Reeves G.D.**[2], **Friedel R.H.W.**[2]

[1]UCLA, Los Angeles, CA 90095-1567, USA

[2]Los Alamos National Laboratoty, NM 87545, USA

Data assimilation is becoming an increasingly important tool for both understanding and prediction of space physics processes. In this study, we demonstrate how data assimilation can help to estimate unknown parameters in a radial diffusion model of acceleration of relativistic electrons during magnetic storms in the Earth's radiation belts. We apply 'state augmentation' method and Extended Kalman filter to estimate the model's lifetime parameter of high-energy electrons by assimilating observations from CRRES satellite. Systematic variations in the estimates for this parameter are attributed to a complex nature of the competing effects of various acceleration and loss processes.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

Suprathermal Electron Fluxes in the Near Plasma Sheet and Substorm-Related Current Disruptions

Koperski P.[1], **Sauvaud J.-A.**[2]

[1]Astronomical Observatory of Jagiellonian University, PL-30 244 Cracow, Poland

[2]CESR, F-31028 Toulouse Cedex 4, France

Substorm-related current disruptions and magnetic field dipolarizations in the near plasma sheet are often accompanied by changes of parallel fluxes of low-energy electrons.We consider the role, such changes can play in the substorm onset, from the point of view of current-disruption model and ballooning mode instability. We use the observations from the Interball Tail- and geostationary satellites and the ground based magnetic data.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Quasi-Biennial Impulses of Solar Activity

Zieba S., **Koperski P.**, **Kulak A.**

Astronomical Observatory of Jagiellonian University, PL-30 244 Cracow, Poland

We analyse time series of five indices of solar activity (ISN, Lymann alpha, FeXIV Coronal Index, Ott 2800, Cra 810) for the years 1952–1999 (cycles 19–22). The harmonic analysis and the Gauss filtering techniques are applied to investigate the variations of 1–3 year impulses. We can identify multipeaked temporal structures similar for all the indices. The structures appear at different phases of the 11-year cycle and seem to be independent on its shape. These temporal structures may be related to the two-dynamo model suggested by Benevolenskaya near the top of the convection zone.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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Solar Wind Conditions at the Times of Generation of Interball Flux Transfer Events

Korotova G.[1], **Sibeck D.G.**[2], **Rosenberg T.**[3], **Petrov V.G.**[1], **Styazhkin V.**[1]

[1]ISMIRAN, RU-142190 Troitsk, Russia

[2]GSFC/NASA, Baltimore, MD 21228, USA

[3]IPST/UMD, College Park, MD 20742-2431, USA

We present the results of a statistical study of 900 flux transfer events (FTEs) observed by the Interball-1 spacecraft. We perform a statistical survey of FTE occurrence as a function of latitude, local time, radial distance from Earth. We examine solar wind conditions observed by the Wind, IMP 8, and Interball-1 spacecraft at the times of FTEs. We perform the study to establish solar wind conditions favorable for generation of multiple FTE events. We undertake these tasks because there is a possibility that different mechanisms produce the events under different solar wind conditions and at different locations. We determine whether events originate along a tilted subsolar merging line during periods of southward IMF orientation, or at high-latitudes during periods of northward IMF orientation. We test the solar wind conditions to determine whether events generated by solar wind/foreshock pressure pulses move across the magnetopause in a direction determined by the orientation of solar wind discontinuities striking the magnetosphere.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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The Influence of Solar Activity on the Atmospheric Drag of Artificial Satellite

Koshkin N.[1], **Korniychuk L.**[1], **Korobeynikova E.**[1], **Strakhova S.**[1], **Ryabov M.I.**[2]

[1]Astronomical Observatory of Odessa University, UA-270014 Odessa, Ukraine

[2]Odessa Observatory of Radio Astronomical Institute, Ukrainian National Academy of Sciences, UA-270011 Odessa, Ukraine

The flux of the charged particles and UV-radiation of the Sun is warming up the upper atmosphere of the Earth. The density variations of the Earth atmosphere on height of 300–800 km lead to change of the braking rate of artificial satellites. The analysis of movement of artificial satellites are submitted and reaction of near-Earth space on a change of solar activity is considered. The frequency spectrum of the solar flux variations and observable parameters of satellites movement is analysed. The features of artificial satellite's braking at re-entrance in dense layers of atmosphere at heights of 250–150 km are considered also.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

SEP Acceleration at Evolving CMEs

Kota J.

University of Arizona, Lunar and Planetary Laboratory, Tucson, AZ 85721-0092, USA

Gradual solar energetic particle (SEP) events are believed to be accelerated at CME driven shocks. Shocks driven by realistic CMEs are neither simply quasi-perpendicular nor simply quasi-parallel: the geometry and the shock strength shall constantly change as the CME evolves. The shock is likely to be quasi-parallel when it forms and becomes more parallel at later stages (*e.g.*, Lee and Tylka 2005). The downstream sheath region immediately behind the shock has a structure of its own, which may play a significant role in the SEP acceleration process. We present numerical simulations adopting a Lagrangian scheme which is designed to handle the evolution of the shock. The scheme follows the moving magnetic field lines, which are wrapped around the expanding CME, and are pushed by the ejecta. We present numerical simulation results and discuss their implications.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

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Ion Temperature Dynamics in the Plasmasphere from INTERBALL Measurements during Minimum and Maximum Phases of Solar Cycle

Kotova G.[1,2], **Bezrukikh V.**[1], **Verigin M.**[1], **Smilauer J.**[3]

[1]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

[2]Institute of Geosphere Dynamics, Russian Academy of Sciences, RU-119334 Moscow, Russia

[3]Institute of Atmosphere Physics, Academy of Sciences of the Czech Republic, CZ-141 31 Prague, Czech Republic

INTERBALL 1, 2 and MAGION 5 (1995-2001) cold plasma measurements are used to deduce proton temperature and density distributions in the Earth's plasmasphere. Proton temperatures in the inner plasmasphere are compared along the magnetic field to electron and ion temperatures measured by DMSP satellites in the high altitude ($\sim$830 km) ionosphere. For $1.4 < L < 2.8$ up to geomagnetic latitudes of 35 degrees night time plasmaspheric temperatures are found to be nearly equal to ionospheric electron temperatures both for minimum and maximum solar cycle phases, not in line with modern model calculations. Ion temperature dynamics in the plasmasphere is considered during moderate magnetic storm development. It is found that on the night side ion temperature is depressed during storm main phase, but at the storm recovery phase the temperature is enhanced exceeding quiet time values. Such temperature behavior should be a consequence of plasmasphere-ionosphere coupling during magnetic storm development and plasmasphere–ring current interactions in the recovery phase.

This work was partially supported by RFBI Grant 04-02-16666a, and Program OFN 16 of the Department of Physical Sciences of the Russian Academy of Sciences.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

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The Geomagnetic Storms and Substorms Influence to the Middle Latitude Whistler Activity

Kovac A.

Geomagnetic Institute Belgrade,11306 Grocka, Belgrade, Serbia

Geomagnetic disturbances change the behavior of the magnetosphere and they might influence the whistler activity. The focus of investigation is to compare the geomagnetic storm influence and the substorm influence to this activity. It was noticed that difference between this two influences exists and it is presented by this work.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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On the Energy Dependence the Relative Contributions Ionospheric and Solar Sources of the Ring Current Protons

Kovtyukh A.S.

Skobeltsyn Institute of Nuclear Physics, Moscow State University, RU-119992 Moscow, Russia

According to AMPTE/CCE date obtained during typical magnetic storm ($Dst =$ –120 nT) are calculated that on $L = 6$–7 ionospheric protons part in the ring current monotonous decreased from 83% to 25–30% with increasing the protons energy from 5 to 315 keV. Evidenced that during storm main phase the core of ring current ($L = 3.7$–4.7) enriched by solar protons with $E = 10$–200 keV (maximal effect achieved at $E = 20$–50 keV).

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Earth's Radiation Belts Ions Empirical Models

Kovtyukh A.S.

Skobeltsyn Institute of Nuclear Physics, Moscow State University, RU-119992 Moscow, Russia

On the data base of the experiments realized during period from 1961 to 2000 years (Explorer-12, Explorer-14, Injun-5, OV1-19, Explorer-45, Molniya-1, Molniya-2, ATS-6, ISEE-1, AMPTE/CCE, Gorizont-21, CRRES, Gorizont-35, SAMPEX, Polar and other satellites) new empirical models of fluxes distributions for protons, helium, oxygen and other ions in the Earth's radiation belts are presented and discussed.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

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Soliton-Similar Nature of 11-Years Solar Activity Cycle

Kozlov V.I., **Markov V.V.**

Yu. G. Shafer Institute of Cosmophysical Research and Aeronomy, Siberian Branch of the Russian Academy of Science, RU-677980 Yakutsk, Russia

Non-stationary transitional oscillatory process of polarity reversal of Sun general magnetic field with duration 2-4 year is established: U-shaped dynamics in wavelet-representation of variations of galactic cosmic ray flickers index: ~ 7, 13–14 and ~ 7 rotations of the Sun, respectively. Transitional oscillatory process of polarity reversal are completed sharp and deep decrease of GCR intensity on a declining branch of 11 years cycles (1972, 1982, 1991 and 2003 years). Duration of transitional oscillatory process is in inverse dependence from amplitude 11 years cycle, that indicate on soliton-similar ("soliton of envelope") nature of 11-years cycle. 'Abnormal' solar activity in 1972 and 2003 are caused increase duration of relaxation oscillations in 'weak' cycles (20 and 23). Reduction of amplitude current 23 cycles is accompanied by increase of its duration that can mean the begun failure of 11-years cyclicity. The constancy of energy allocated in an individual cycle, *i.e.*, soliton-similar nature of a 11-years cycle indicate that 11 years cyclicity – is effective mechanism of regulation of energy preventing the Sun from 'overheat' at critical temperature.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

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Soliton-Similar Image of Heliospheric Storm

Kozlov V.I., **Markov V.V.**

Yu. G. Shafer Institute of Cosmophysical Research and Aeronomy, Siberian Branch of the Russian Academy of Science, RU-677980 Yakutsk, Russia

When the general magnetic field sign of the Sun inverses, the variations of a ratio of the quadrupole field component to its dipole part manifest as a change of heliospheric current sheet structure from the two-sector structure to four-sector and, further, to multi-sector ones. At this time in heliospheric current sheet the soliton-similar wave packet ("soliton of envelop") is formed which defines the wavelet-image of heliospheric storm in cosmic rays and solar wind parameters. 'Decoding' multi-sector structure of HCS as "soliton of envelope", allows us for the first time to identify the contribution quadropole components of the general magnetic field of the Sun in parameters of a solar wind and cosmic rays.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Forecast of Space Weather in Real Time on the Base Cosmic Rays Monitoring

Kozlov V.I., **Kozlov V.V.**, **Markov V.V.**

Yu. G. Shafer Institute of Cosmophysical Research and Aeronomy, Siberian Branch of the Russian Academy of Science, RU-677980 Yakutsk, Russia

In basis of forecast method of large-scale solar wind disturbances lays the effect revealed us earlier. The essence of the phenomenon consists that else before registration on the Earth the large-scale interplanetary disturbances, being a source of a geomagnetic storm, high-altitude neutron monitors register flickers of sky sphere in cosmic rays-effect 'halo' or luminescence of disturbances source in 'light' of cosmic rays. Disturbances of an interplanetary magnetic field during strengthening solar activity are manifested in the form of so-called 'magnetic cork'. Particles, moving under small corners to direction of interplanetary magnetic field, free get through it. Other part of cosmic rays which moves under greater corners to a magnetic field – is reflected from a cork. Owing to laws of preservation

the particles reflected from a magnetic cork are focused in anisotropic bunches which are the indicator of interplanetary disturbances coming to the Earth. On the Earth similar bunches of cosmic rays also will be manifested as predictors.

The given work is dedicated to practical implementation of a method early detection of large-scale disturbances of interplanetary environment on the basis of cosmic ray monitoring, in particular, creation on the prognostic expert system “FORSHOCK”. Expert system success has passed approbation during unique events of current XXIII cycles, when the most powerful solar flares were registered, accompanied by giant particle fluxes of cosmic ray and unusual by powerful magnetic storms. Results of monitoring made in Arctic Center of Cosmo physical Prognosis of IKFIA in real-time regime during 2000–2005 indicate on capability of a long-term forecasting (with advance $WT = 3 \pm 1$ solar rotations) and operative forecast (with advance $Wt \sim 1$ days) of heliospheric storms, and also isolated Forbush-decreases (http://ikfia.ysn.ru/fluctuations/index.php; http://cosmoprognoz.ru/).

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Spectral Investigations of the Solar Radiation during the Total Solar Eclipse on 29.03.2006

Krezhova D.D., **Krumov A.H.**, **Yanev T.K.**

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-Sofia 1113, Bulgaria

Results are presented from examination of the dynamics and spectral distribution of the solar radiation reaching the Earth’s surface during the total solar eclipse on March 29, 2006. The solar spectra were recorded using a multichannel spectrometer OCEAN USB 2000 in 2048 spectral channels in the spectral range 350–1000 nm at a spectral resolution of 0.3 nm. The spectrometric measurements were carried out between the 1st and 2nd and the 3rd and 4th contacts of the total solar eclipse from an observation point situated on the Mediterranean Sea coast, Antalya, Turkey. The spectral data were evaluated using statistical methods such as the Student’s t-criterion, variance analysis and others. The changes in incident solar radiation intensity before and after eclipse totality were found to correlate ($R > 0.998$) with the changes during the total Sun eclipse on August 11, 1999 observed from an observation post on the line of totality situated on the Black Sea cost on Bulgarian territory. In studying the changes in solar radiation within the absorption bands of water vapours and of oxygen it was found that there are fluctuations. They are more significant just before the 2nd and after the 3rd contact of the total solar eclipse. Changes were observed as well in the equivalent width of the absorption bands of water vapours and oxygen.

✓ OTHER RELATED TOPICS: POSTER

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3D Modeling of the Response of the Earth’s Atmosphere to Strong Solar Proton Events

Krivolutsky A.A., **Zakharov G.R.**, **Vyushkova T.Yu.**, **Kukoleva A.A.**, **Kuminov A.A.**

Central Aerological Observator, 3 Pervomayskaya Street, RU-141700 Dolgoprudny, Russia

Fluxes of energetic particles moving from the sun during the periods of its activity is an important source of NOx and HOx chemical compounds in the atmosphere of the Earth. Such additional production of NO and OH destroy ozone at high latitudes in chemical catalytic cycles in the polar atmosphere.

GCM and 3D chemical global transport-photochemical middle atmosphere models have been used for simulation of, wind and temperature response to one of the strongest solar proton events (SPEs) of the 23rd solar cycle. The response of ozone, circulation and temperature was investigated using 3D global models. It was assumed in the photochemical scheme that approximately one molecule of NO and two molecules of OH are produced for each pair of ions that are created. SPEinduced ionization rates have been calculated using high time-resolution satellite measurements of solar proton fluxes provided by GOES. In accordance with calculations the maximum of ionization rates occurred was localized in the mesosphere after SPEs. 3D photochemical calculations showed that ozone was partly destroyed in the mesosphere and stratosphere over both polar regions after SPEs of 4 November 2001, and 28 October 2003, but ozone response was found only over Northern pole after SPE of July 2000, and a weak negative response of ozone over South Pole (night conditions) was found in simulations. The results of model runs showed that SPE-induced ozone depletion leads to corresponding disturbances in temperature and dynamics, and reveals the possibility for forecast.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Imaging of the Total Solar Eclipse on 29.03.2006

Krumov A.H., **Krezhova D.D.**

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-Sofia 1113, Bulgaria

Combined videometric and spectrometric observation was carried out during the total solar eclipse on March 29, 2006. The measurement equipment was installed on a place located close to the central line of the totality, near Manafgat, Turkey. A series of images of the solar disc and corona was obtained during all phases of the eclipse. The paper presents possibilities for application of registered images

in studies of the shape, orientation, structure and dimensions of the solar corona and its separate zones. Structures with dimensions of over 6–7 solar radiuses are observable. After appropriate image processing fine invisible cloud structures can be discovered. This fact is of high importance for accurate determination and consideration of the measurement conditions at following processing and interpretation of spectrometric and radiometric data.

✓ OTHER RELATED TOPICS: POSTER

On the Physics of Collisionless Shocks: Cluster Investigations and Results

Kucharek H.[1], **Moebius E.**[1], **Mouikis C.**[1], **Lee M.**[1], **Yong L.**[1], **Miao B.**[1], **Scholer M.**[2]

[1]University of New Hampshire, 39 College Road, Durham, NH 03824, USA

[2]Max-Planck-Institut für extraterrestrische Physik, D-85741 Garching, Germany

Collisionless shocks can be found in many astrophysical settings but the Earth's environment is easiest to access. There are many motivations to investigate processes at shocks. One is to improve our current knowledge of nonlinear plasma physics, collisionless dissipation, and particle reflection and acceleration. For instance the foreshock region of the Earth's bow shock is populated by a variety of waves and particle populations allowing us to study wave–particle interactions. Furthermore, magnetic reconnection is responsible for the release of stored magnetic energy into kinetic and thermal energy of the plasma. In the Petschek reconnection heating and acceleration occur mainly in the slow mode shocks, which bound the reconnection wedge. But which collective processes are able to generate and maintain a slow mode shock? The Cluster mission and related simulation and theoretical considerations provided many new insights to the above-mentioned topics. In this presentation we will review advances made in ion reflection, thermalization and ion acceleration at collisionless shocks using cluster data.

✓ CLUSTER OBSERVATIONS AND THEORY: ORAL

Resonant Energy Conversion of 3-minute Intensity Oscillations Into Alfvén Waves in the Solar Atmosphere

Kuridze D., **Zaqarashvili T.**

Abastumani Astrophysical Observatory, GE-383762 Abastumani, Georgia

It is generally believed that the solar 3-minute oscillations above active regions can not penetrate into the corona due to the sharp temperature gradient in the transition region. However the oscillations with the same period are frequently observed in the corona by space satellites SOHO (Solar and Heliospheric Observatory) and TRACE (Transition Region and COronal Explorer). Here we solve weakly nonlinear MHD equations and show that 3-minute acoustic oscillations may effectively transmit the energy into the Alfvén waves in the region,where the sound and Alfvén speeds approximately equal.Here the harmonics of Alfvén waves with twice period and wave-length are exponentially amplified indicating a resonant energy conversion. Amplified Alfvén waves may easily pass the transition region and deposits the energy back to the density perturbations in the corona. The process can be of importance in coronal heating.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Modeling the Thermal Structure of Topside Ionosphere and Plasmasphere

Kutiev I.[1], **Marinov P.**[2]

[1]Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Institute of Parallel Processing, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

Paper describes a generalized approach of empirical modeling of thermal plasma parameters in the upper F region and inner plasmasphere, based on satellite data. In several consecutive models this approach has been developed. The models provide electron temperature (T_e), plasma density scale height (T_s) and the upper transition height (T_h) between ionospheric F region and plasmasphere as functions of season (time of the year), geomagnetic latitude, local time and solar and geomagnetic activity indices, as F10.7 and Kp. Mathematically, the model is represented by a 5-dimensional polynomial, which coefficients are obtained by fitting the polynomial to the data. Specification of data limits and sampling along the model axes are found crucial for successful modeling. Special attention is paid to the error assessment. The scatter of data (standard deviation around the average) is compared with the model error (standard deviation of data from model prediction) to evaluate the gain of accuracy of the models. The paper presents samples of modeling T_e in

topside ionosphere (based on Hinotori data) and in the inner plasmasphere (Akebono data), as well as the derivatives of electron density profiles T_{s} and T_{h}, measured by topside sounders on Alouette and ISIS satellites.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

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Observations of the Sun–Earth System within the CORONAS-F Mission

Kuznetsov V.D.

Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, Russian Academy of Sciences, RU-142190 Troitsk, Russia

The results of the study of solar active phenomena and their manifestations in near-Earth space observed in the declining phase of the current activity cycle within the CORONAS-F space mission are submitted. The outstanding solar events recorded in October–November 2003, January and September 2005 and the related effects in geospace are described.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Scenaria for Laboratory and Computer Simulations of Global Effects in the Earth's Magnetosphere Initiated by Giant CME

Zakharov Yu.P.[1], **Ponomarenko A.G.**[1], **Kuznetsova T.V.**[2], **Kuznetsov V.D.**[2], **Nakashima H.**[3], **Vchivkov K.V.**[1]

[1]Institute of Laser Physics (ILP), Siberiam Branch of the Russian Academy of Sciences, RU-630090 Novosibirsk, Russia

[2]IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

[3]Department of Advanced Energy Engineering Science, Kyushu University (KU), Fukuoka 816-8580, Japan

Laboratory simulation provides us with additional ample opportunities for better understanding causes and effects initiated by huge CME.To study possible global after-effects in the Earth's magnetosphere after its extreme compression (to distance Rm up to 2–3 Re) by giant CME, an AMEX experiment in ILP was proposed and started recently at KI-1 facility (with the diamagnetic Laser Plasma of kJ-energy and unique magnetic dipole $M \sim 1000$ T cm^3). A simplified MHD-model of such magnetosphere was developed by ILP and confirmed in its last 3D/PIC-simulations by hybrid KU-code under conditions of highly-magnetized ions with Larmor radius < 0.3 Rm (corresponding to parameters of AMEX), while indeed it is necessary to take into account not only a plasma-field pressure balance, but also the effects of magnetic fields frozen in expanding plasma flow that are usually observed in CME. To do it we plan up-grated AMEX-B experiment with the using of additional and B_z-magnetized background plasma, embedded between the Laser Plasma and dipole. A large-scale ∼1 m chamber KI-1 with the source of high-density proton background gives an opportunity to generate shock-like structure in front of Laser Plasma, therefore we hope to reproduce for the first time the most important features of CME-magnetosphere interaction.

However, the main unsolved problem is geoefficiency of interaction of CME with magnetosphere. The problem explored by IZMIRAN led to new approach in study of geoeffective parameters describing interaction of solar wind (or CME flows) and magnetosphere. To understand physical mechanism governing the geoeffective interaction we attract a reconnection model of IZMIRAN taking into account mutual orientation of the geomagnetic moment M, electric field of the solar wind E and IMF during orbital and daily motions of the Earth (depending from astronomical season and UT). Studies at IZMIRAN based on spaced and ground-based data showed that magnetic state of magnetosphere (and its parameters: Rm, shape etc) are controlled by mutual orientation of vectors M, E, and IMF. During planned AMEX-B we can investigate influence of the most important B_z and B_y components of IMF on position, shape and symmetry of magnetopause. We will investigate too effects of interaction of huge CME leading to super geomagnetic storms by simulating conditions (in terms of key parameters of the model) in AMEX-B experiment.

As a goal of our laboratory simulations and PIC-modelling we considered such kind of Space Weather Hazards as world-wide SC-effect of the magnetosphere compression under conditions of finite size Rm/3 of conductive dipole surface and with the different orientations of IMF in plasma flow. Prediction of the enormous $SC > 1000nT$ is necessary over its global effects: changes of radiation belts, huge telluric currents. Such effects caused by CME can supply an essential energy input to the magnetospherical processes of Mercury or its interior, and our simulative results can be a base for interpretation of future data of MESSENGER and BepyColombo missions.

This work is supported in part by CRDF Cooperative Grant Program (Project # 14864 of ILP) and by Russian Fund for Basic Research, Grant 06-05-64998 (IZMIRAN).

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Solar Activity Cycles in Global Surface Temperature and Angular Velocity of the Earth

Kuznetsova T.V., **Tsirulnik L.B.**, **Petrov V.G.**

IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

We study solar activity and surface temperature variations (in the first place at periods of main solar cycles: $T \sim 11$ yr, $T \sim 22$ yr) to understand a possible influence of solar activity on climate changes in different ranges of periods. The problems are trends, quasi-periodicities and noise in solar and climate processes. We use a method of a non-linear spectral analysis named by us the Method of Global Minimum. MGM is capable of making a self-consistent selection of trends from a data set and singling out harmonics with varying phase and amplitude. We use data: of sunspot numbers W for the period 1700–2003; North and South Hemisphere surface temperatures (NH, SH), Global Temperature (GT) for 1000–1990 and annual anomaly of variations of angular velocity of the Earth W for the period 1656–2000. Spectral peaks of our spectra have confidence statistical level higher than 95%. Trends in W and GT show synchronous increasing for 1700–2000. The trends have the highest power in both spectra that point to the main contribution of long-term variations to the changes in the data. Connection of variations of solar activity and terrestrial temperature on different scale has principal different character that points to different physical mechanisms. In particular, time changes of power stationary cycles at periods $T = 30$ yr and $T = 10$ yr in W and GT vary in opposite phase. Analysis shows that even 11-yr solar cycles correspond to cooling of GT, but odd ones to warming. This result about disparity of the 11-yr cycles is not taken usually into account in atmospheric sciences. Non-stationary 22-yr oscillations in both data sets (W and GT) have synchronized time variations including time intervals of regime changes (from amplitude decreasing to increasing). Besides, the cycle at $T = 22.3$ yr in the NH and SH vary in nearly opposite phase and have different amplitudes. The fact that 22-yr cycle reflects asymmetry of solar activity relative to sign of the solar magnetic field points to a physical mechanism: interaction of solar (IMF) and terrestrial magnetic fields. Besides, oscillations of 22-yr cycle in W and GT are in phase that allows to explain the GT 22-yr variations by the atmosphere influence. It should be noted that variations of GT and W have different character of connection on different scales: for instance, cycles in GT and W at $T = 200$ yr vary in opposite phase with the cycle at $T = 200$ yr in angular velocity ω. Cycle at $T = 22$ yr has relative small power in the GT spectrum. Power cycles in the solar and GT spectra (such as at $T = 300$ yr, $T = 200$ yr) can not be explained in terms of this mechanism: an additional mechanism should be elaborated.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Time Changes of Solar Activity and the Interplanetary Magnetic Field at the Earth's Orbit in Different Spectral Bands

Kuznetsova T.V., **Tsirulnik L.B.**

IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

We present results of our analysis of time changes of different frequency components of spectra of the Interplanetary Magnetic Field (IMF) values (measured at the Earth's orbit for the period 1964–2004) and solar activity expressed by sunspot numbers W. Comparison of the spectra is natural because values of IMF have the highest correlation coefficient $C_c = 0.95$ (compared with the other parameters of the solar wind) with W. This result allows to consider W as indicator of magnetic flux carried by the solar wind to the Earth's orbit. A method of non-linear spectral analysis named by us the Method of Global Minimum (MGM) is used to calculate the spectra. Spectra of the IMF and W are calculated to detect oscillations with the same periods including non-stationary (with varying phase and amplitude). All discussed peaks in the both spectra have statistical significance higher than 0.95. Analysis shows presence of cycles with the same periods in both spectra: oscillations with the periods $T = 10.8$ year, $T = 8.8$ year and $T = 3.7$ year present in both long-periodic parts of the spectra. However, time changes of these oscillations demonstrate different character of connection between the solar activity and the IMF value. In particular, solar cycle at period $T = 10.8$ yr varies in phase with the cycle at the same period from the IMF spectrum. But the solar oscillations at the period $T = 8.8$ yr have phase shift relative to the IMF oscillations. Short-term spectral bands of both spectra in vicinity of well-known periods $T \sim 1.3$ yr and $T \sim 150$ days detected earlier both in the solar and solar wind data are discussed. The most power non-stationary oscillations at $T = 1.3$ yr from the short-term part of the IMF spectrum do not present in the W spectrum. Instead we found power non-stationary oscillations at $T \sim 1.0$ yr in the solar spectrum. We suggest explanation of the cause of difference of these periods. Complicated structure of spectral band of the IMF spectrum in vicinity of periods $\sim$150 days includes non-stationary sinusoid at $T = 142$ days and stationary ones at $T = 137$ days, $T = 151$ days is not resolved in the solar spectrum. The solar spectrum has peaks with statistical significance at $T = 134$ days and $T = 142$ days. We discuss too other our results: such as behavior of the trends in the solar activity and the IMF spectra, change of period of the Suns rotation for the last solar cycle (compared with the previous solar cycles for the studied time interval) and others.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Contribution of Geometric Parameters of Interaction of Solar Wind and Terrestrial Magnetic Field into Geomagnetic Activity

Kuznetsova T.V., **Laptukhov A.I.**, **Kuznetsov V.D.**

IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

Geomagnetic activity (GA) is determined in our approach by two kinds of causes: 1) time variations of the solar wind parameters, sources of which are time variations of solar activity; 2) time variations of mutual orientation of geomagnetic moment M, IMF, electric field of the solar wind E, sources of which are mainly annual and daily motions of the Earth. We stressed the geometric effect 2) in our study. We present results of our study of dependence of planetary GA from geoeffective parameters taking into account orientation of the magnetic moment of the Earth relative vectors of the IMF and E. Geoeffective invariant (relative to a coordinate system) parameters have clear physical sense of components of electric field of the solar wind along special directions of the M. We take as our data base (for the period 1964–2000 of space measurements at 1 a.u. at ecliptic plane) all values of Kp, Dst and Ap indices of planetary GA while there was simultaneous coverage of the IMF and solar wind velocity (to calculate E). We attract for calculation of these parameters a reconnection model taking into account annual and daily rotations of the Earths dipole. Results of our analysis show that main geoeffective parameter Emv (component of the E vector perpendicular both to M and the solar wind velocity V) can explain 95% variations of geomagnetic indexes. At last we evaluate direct contribution of geometric factors in the geoeffective parameters (calculated on the basis of measurements of the IMF, V and orientation of the M vector in GSE) on the GA. Variations of angle between the vectors of IMF and M can explain 30% of variations Kp. Variations of our pure geometric parameter (determined by mutual orientation of vectors E and M) can explain 50% of observed variations of Kp and 75%Dst (for invariable values of E in the solar wind). This means that GA can reach very high levels without changing values of solar wind parameters: from geomagnetic state $Kp = 4$ ($Ap = 27$ nT, $Dst = 30$ nT) up to $Kp = 8$ ($Ap = 207$ nT, $Dst = -180$ nT) for invariable values of E in the solar wind ($E > 8$ mV/m) by changing only angle between E and M. We present too results of our study of dependence of planetary GA from angle between the vectors of the solar wind velocity V and geomagnetic moment M. This angle is responsible for less than 15% of variations of the geomagnetic indices.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Annual and UT Variations of Geomagnetic Activity for Different Intensity Levels

Kuznetsova T.V., **Laptukhov A.I.**, **Tsirulnik L.B.**

IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

Geomagnetic activity (GA) is well-known to be described by season variation with maxima in vicinity of the equinoxes and minima near the solstices. Cause of this annual variation is still a matter of contraversy. Season modulation of geomagnetic activity is generally attributed to one or more of three mechanisms known as axial, equinoctial and Russell-Mcpherron. Besides, Clua de Gonzales *et al.* (2001) using monthly averages of geomagnetic indices found peak in July for ranges of high levels of geomagnetic activity that is outside of the known seasonal profile of GA. It is very important to study regularities of behavior of GA for large intensities to increase our predictive capability for space weather. The purpose of our study was to obtain annual and UT variation of geomagnetic activity for different levels according to intensity. The other aim was to detect a day (in July or not) inside a month of the highest geomagnetic activity. At last we attract for explanation of our results our model of geomagnetic activity based on variation of mutual orientation of electric field of the solar wind relative to geomagnetic moment during orbital and daily motions of the Earth. For our study we used 3-hour geomagnetic indices Kp (1932–2004) and aa (1868–2004), hour indices Dst (1957–2004). We obtained for all the geomagnetic indices that as the level of intensity increases, the classical season variation has additional peaks. For strong disturbances in range of $Kp = 8$–9 we obtained clear non-classical season variation with absolute maximum on 4 April (plus minus 7 days) and two comparable peak 16 July, 28 September (the same error bar for both days). We see the same positions of peaks and their intensity for level $aa > 200$: absolute maximum on 4 April and less intensive maxima in 16 July and 28 September. Behavior of reaching the peaks in equinoxes differ from the summer solstice peak: gradual increasing of geomagnetic activity before maximum at the equinoxes and sharp rise of geomagnetic activity in July from low activity to its highest level that lasts for approximately 2 weeks. Annual variation of $Dst < -200$ nT shows two clear comparable peak on 4 April and 25 November and less intensive peaks in July and September. Our analysis showed that UT variation of all discussed indices for the high level of geomagnetic activity ($Kp > 8$, $aa > 200$, $Dst < -200$ nT) have clear additional maxima at $\sim$6 UT and $\sim$18 UT on the usual statistical profile of the UT variations of the indeces. We suggest explanation for appearance of large geomagnetic activity in July and November based on our model.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Simulating Magnetospheric Energy Hubs: Methods and Results for Magnetic Reconnection in Global MHD Models

Laitinen T.V.[2,1], **Janhunen P.**[2,1], **Pulkkinen T.I.**[1,3], **Palmroth M.**[1], **Koskinen H.E.J.**[1,2]

[1]Finnish Meteorological Institute, Space Research, PL 503, FIN-00101 Helsinki, Finland

[2]University of Helsinki, Department of Physical Sciences, PL 64, FIN-00014 Helsinki, Finland

[3]Presently at: Los Alamos National Laboratory, PO Box 1663, MS D466, Los Alamos, NM 87545, USA

Magnetic reconnection is a key process in the magnetosphere, playing a major role in energy transfer and conversion both at the magnetopause and in the tail. There are still many open question about its nature and suitable ways to characterize it in a fully three-dimensional setting with realistic, non-symmetrical boundary conditions. In global MHD simulations reconnection appears due to explicit or numerical diffusion, and comparison with theoretical models is not straightforward.

We use the Gumics-4 global MHD simulation to investigate the appearance and impact of reconnection at the magnetopause and in the tail under different solar wind conditions. We present a three-dimensional topological definition for the magnetopause x-line, and show that the x-line crosses the subsolar region for all but almost exactly northward orientations of the IMF. This aspect thus seems consistent with the prediction of the component reconnection model. We analyze the magnetospheric convection associated with the opening of field lines at the magnetopause and their closure in the tail. We also use Poynting vector divergence to quantify the energy conversion associated with reconnection, and show that magnetic merging measured this way is concentrated in the subsolar region on the magnetopause. In the tail a similar method reveals that half of all energy entering the magnetosphere is transformed by tail reconnection.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

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Modeling the Effects of Cold-Dense and Hot-Tenuous Plasma Sheet on Proton Ring Current Energy

Lavraud B., **Jordanova V.K.**

Space Science and Applications, Los Alamos National Laboratory, Los Alamos, NM 87545, USA

The ring current strongly depends upon the properties of the plasma injected from the magnetotail. Motivated by the knowledge that this typically hot and tenuous plasma can, at times, be colder and denser, we have run a kinetic ring current model with different plasma sheet boundary conditions, but preserving a constant plasma pressure, during a “test” time interval conducive to a storm development. The results show that, even though the energy density of the injected plasma is kept constant, the proton ring current energy significantly increases as the injected plasma is colder and denser. While cold and dense plasma may convect deep inside the ring current region, hotter plasma is more subject to magnetic drifts and quickly drifts toward dusk with lower energization. This modeling result demonstrates that the presence of cold and dense plasma in the magnetotail may lead to an increased ring current during an ensuing storm

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

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Wave Models for Physical Radiation Belt Models

Lefeuvre F., **Pokhotelov D.**

LPCE-CNRS, F-45071 Orleans Cedex 2, France

The modelling of radiation belts require statistical models of : (a) power spectra of electric and/or magnetic field components and of (b) polarisation and wave normal distributions, for all types of emissions which can contribute to the acceleration or to the precipitation of electrons from the radiation belts (VLF transmitters, chorus, plasmaspheric hiss, magnetosonic waves, ion-cyclotron waves). A general approach for wave modelling is reviewed. Results of a first wave model derived from DE-1 data (Andre *et al.*, Annales Geophysicae, 20:981–996, 2002) are presented and discussed. Orientations for future wave models developments are proposed. They take into account of published results on wave propagation characteristics and of satellite data presently available for statistical descriptions of power spectra and wave normal directions.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Self-Organized Criticality in the Central Plasma Sheet: Initial Results

Liu W.[1], **Charbonneau P.**[2], **Thibault K.**[2], **Morales L.**[2]

[1]Space Science Branch, Canadian Space Agency, Toronto, Ontario M5C 2W7, Canada

[2]Department of Physics, University of Montreal, Montreal, Quebec H3T 1J4, Canada

With recent analyses of geomagnetic and auroral data showing robust scale-free distributions of magnetospheric dynamics, theoretical explanation of these findings have become a growing concern. Recently we proposed that the central plasma sheet of Earth's magnetosphere can be represented as a two-dimensional cellular automaton driven by boundary conditions from all sides. We further argued that the model should be easily amenable to self-organization and intermittent energy avalanches. In this talk, we present initial computational results confirming this conjecture. We will comment on the physical significance of our findings.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

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Climatology of the Equatorial Anomaly in the Neutral Density

Liu H.[1], **Luehr H.**[2], **Watanabe S.**[1]

[1]Hokkaido Univeristy, Kitaku, Sapporo 060-0808, Japan

[2]GFZ Potsdam, D-14473 Potsdam, Germany

The thermospheric mass density at 400 km altitude reveals a surprising feature similar to the equatorial ionization anomaly (EIA). It maximizes not at the sub-solar point but develops a double-hump structure with two density peaks near ± 25 deg magnetic latitude and a density trough at the dip equator. Based on four years of CHAMP accelerometer measurements the climatological characteristics of this equatorial thermospheric mass density anomaly (EMA) are studied. The most pronounced EMA structure is observed during equinox months. Near solstices, the EMA is asymmetric about the dip equator as expected. There is a large latitudinal displacement of the density bulges towards the summer hemisphere by about 15 deg, along with the amplitude in the summer hemisphere higher than that in the winter hemisphere. Furthermore, the short wavelength solar flux has a strong influence on the EMA double-hump structure. During times of low solar flux the signature becomes less clear, but at high level (F$10.7 > 150$) a distinct density trough forms at the dip equator. These climatological variations closely resemble those of the EIA, hence supporting the argument that EIA is likely responsible for the EMA formation.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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The Role of Field-Aligned Currents in the Saturation of the Polar Cap Potential

Lopez R.[1], **Hernandez S.**[1], **Wiltberger M.**[2], **Lyon J.**[3]

[1]Florida Institute of Technology, Melbourne, FL 32901, USA

[2]NCAR/HAO, Boulder, CO 80301, USA

[3]Dartmouth College, Hanover, NH 03755, USA

During southward IMF, for small values of VBz in the solar wind the potential is linearly dependent on VBz, but for large values of VBz the potential behaves nonlinearly and reaches a saturation value. The Lyon–Fedder–Mobarry MHD simulation reproduces this effect. We will present a physical model for saturation based on the force on the solar wind exerted by field-aligned currents, whose distribution changes during saturated periods. We will also present observations to support our basic conclusion that the flow of field-aligned current into the magnetosheath along open field lines is the agent that produces the saturation effect.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

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Effects of Solar and Magnetospheric Forcing on the Ionosphere and Upper Atmosphere

Lu G.

National Center for Atmospheric Research, Boulder, Colorado, CO 80307-3000, USA

Earth's ionosphere and upper atmosphere are subject to several geophysical forcings originating from the Sun. The interaction between the solar wind and the Earth's magnetosphere results in a fraction of the solar wind energy and plasma being transmitted into the

magnetosphere, and subsequently into the ionosphere and upper atmosphere in the forms of auroral precipitation and Joule frictional heating. Solar energetic particles penetrate into the upper and middle atmosphere to cause significant ionization and chemical effects.

Solar UV and EUV radiation is the main source of energy for heating, ionization, and photochemical reactions in the upper atmosphere and ionosphere. This paper will highlight some salient features of the ionosphere and upper atmosphere in response to the various solar and magnetospheric forcings, and discuss their relative impacts on the upper atmosphere.

Observational and numerical modeling results from a number of recent geomagnetic storms will be presented.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Simulating Interacting Coronal Mass Ejections from Sun to Earth

Lugaz N.[1], **Manchester W.B.**[1], **Tóth G.**[1], **Roussev I.**[2], **Gombosi T.I.**[1]

[1]Center for Space Environment Modeling, University of Michigan, Michigan MI 48109-2143, USA

[2]Institute for Astronomy, University of Hawaii, Honolulu, HI 98622, USA

CMEs interacting on their way to Earth are believed to be the cause of some of the longest-lived and largest geomagnetic storms. They are also often associated with large Solar Energetic Particles events.

We will present simulations of interacting CMEs performed at the Center for Space Environment Modeling using different solar wind and CME initiation models. In the case of real events, we will discuss the ability of the model to reproduce observations such as Thomson scattered white light emissions (LASCO coronographs) and near-Earth satellite observations. We will also present synthetic coronograph images of the CMEs as if they had been observed by the STEREO Heliospheric Imagers.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Global Ionospheric Convection Patterns Obtained from Statistical Model of Field-Aligned Currents

Lukianova R.[1], **Christiansen F.**[2]

[1]Arctic and Antarctic Research Institute, RU-199397 St. Petersburg, Russia

[2]Danish National Space Center, DK-2100 Copenhagen, Dania

A new approach for modeling the global distribution of ionospheric electric potentials utilizing high-precision maps of FACs derived from measurements by the Ørsted and Champ satellites as input to a comprehensive numerical scheme is presented. The boundary conditions provide a correct treatment of the asymmetry of conductivity and sources of electric potential between the northern and southern hemispheres. Based on numerical simulation the basic convection patterns developed simultaneously in both hemispheres for equinox and summer/winter solstices are obtained. A rather complicated dependence of the convection patterns on season linked with the sign of IMF BY is found. In particular, the combinations of BY $>$ 0/summer and BY $<$ 0/winter produce the highest circular flow around the pole in comparison with the combinations of BY $<$ 0/summer and BY $>$ 0/winter. The model predicts that the summer cross-polar potentials are smaller than the winter potentials. The value of the ratio depends on the combination of season/IMF BY sign. The ratio is found to be greater for the combination of BY $>$ 0/southern summer and BY $<$ 0/northern summer. The smallest value is obtained for the combination of BY $<$ 0/southern summer and BY $>$ 0/northern summer under northward IMF conditions. At middle latitudes the main features of the MLT-profile of the westward and equatorward electric field components are reproduced. The model predicts that during solstice the equatorward component of the mid-latitude electric field is negative at all local times for BY $<$ 0 and positive for BY $>$ 0.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Solar Wind Discontinuity Driving of Large-Scale Disturbances of the Coupled Magnetosphere-Ionosphere System

Lyons L.R.[1], **Lee D-Y**[2], **Wang C-P**[1], **Mende S.B.**[3]

[1]Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, Los Angeles, CA 90095-1565, USA

[2]Department of Astronomy and Space Science, College of Natural Sciences and Institute for Basic Science Research, Chungbuk National University, 48 Gaeshin-dong, Heungduk-gu, Cheongju, Chungbuk 361-763, South Korea

[3]University of California, Space Sciences Laboratory, 7 Gauss Way, Berkeley, CA 94720-7450, USA

To understand and predict the relations between the solar wind and disturbances of the magnetosphere-ionosphere system, it is necessary to understand what solar wind conditions cause substorms and related disturbances, what conditions do not, and why. We will describe

interplanetary magnetic field (IMF) and solar wind dynamic pressure P changes that lead to substorms and the significant differences in the features of substorms triggered by IMF and by P changes. We will also describe important interplay from simultaneous IMF and P changes that can prevent substorm triggering. This interplay leads to what we call "null events", since the IMF or P change alone would trigger a substorm but the effect of that change is nullified by a simultaneous change in the other quantity. We will then use the plasma sheet continuity equation to show how basic plasma sheet sources and losses account for:

1. The substorm growth phase build up of plasma energy and the Harang electric field reversal,
2. Steady magnetospheric convection events via the finite tail width giving particle flux and energy flux divergence that prevents excess build up of pressures,
3. Substorm onsets via IMF changes or P increases that substantially decrease the inner plasma source but not the loss,
4. Null events via competing effects of IMF and P changes that lead to an unchanged or increased plasma sheet source,
5. Pseudo-substorms via a nullifying IMF or P change that increases the plasma sheet source after onset, terminating substorm expansion before full develop

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Solar cycle variations of the Solar Irradiance and the Coronal Mass Ejection

Makarova L.N, **Shirochkov A.V.**

Arctic and Antarctic Research Institute, RU-199397 St. Petersburg, Russia

Analysis of experimental data shows that variations of the solar UV radiation in Fe XIY line demonstrate evident periodicity with cycle of 10–12 years, which is similar to well-known variations of sunspot numbers (SSN) and with flares activity of Sun. Reconstructed Total Solar Irradiance (TSI) values have a more complex structure where other long-term variations (of order of 30–40 years) are present together with standard 11-year periodicity. Further, a notable increase of the TSI intensity is evident at the end of the last century. Variability of the solar wind dynamic pressure magnitudes, which connected with ejection of the Sun coronal mass demonstrates periodicity of 30–40 years similar to the reconstructed TSI curve. However, periods of maximum of TSI intensity with cycle of 10–12 years correspond to periods of minimal magnitudes of the solar wind dynamic pressure.

So, it is possible to speak about two kind of solar activity: Total Solar Irradiance, which connected with flare activity and strong magnetic field of Sun and dynamic pressure of the solar wind, which connected with coronal mass ejection and weak magnetic fields of Sun. These two factors are important parameters, which characterizes energy of the Sun–Earth system.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Heating and Stress Tensor of Shear Flow of Magnetized Turbulent Plasma

Mishonov T.M., **Maneva Y.G.**, **Hristov T.S.**

Department of Theoretical Physics, Faculty of Physics, University of Sofia, BG-1164 Sofia, Bulgaria

Heating of magnetized turbulent plasma is calculated in the framework of Burgers turbulence [A.M. Polyakov, *Phys. Rev. E.* **52**, 6183]. There is calculated the energy flux of Alfvén waves along the magnetic field. The Alfvén waves are considered as intermediary between the turbulent energy and the heat. The derived results are related to wave channel of the heating of solar corona. After incorporating dissipation of convective plasma waves instabilities [G.D. Chagelishvili, R.G. Chanishvili, T.S. Hristov, and J.G. Lominadze, *Phys. Rev. E* **47**, 366 (1993)] and [A.D. Rogava, S.M. Mahajan, G. Bodo, and S. Marsaglia, *Astronomy & Astrophysics* **399**, 421–431 (2003)] the suggested model of heating can be applied to analysis of the missing viscosity of accretion discs and to reveal why the quasars are the most powerful sources of light in the universe. The theory supposes self-sustained turbulence and magnetic field in a shear flow. We suppose that applied Langevin–Burgers approach to the turbulence can be helpful for other systems where we have intensive interaction between a stochastic turbulent system and waves [T. Hristov, C. Friehe and S. Miller, *Phys. Rev. Lett.* **81**, 5245 (1998)] and [*Letters to Nature* **422**, 55 (2003)] and can be used in many multidisciplinary researches in hydrodynamics and MHD.

✓ OTHER RELATED TOPICS: POSTER

Origin and Evolution of the Solar Wind and Solar Storms Driven by Magnetic Eruptions

Marsch E.

Max Planck Institute for Solar System Research, D-37191 Katlenburg-Lindau, Germany

The magnetic field of the Sun and the plasma properties of its atmosphere determine the origin and evolution of the solar wind. It comes in three main types, as steady fast streams, variable slow flows and transient fast coronal mass ejections. They all are closely associated with the structure and activity of the coronal magnetic field that evolves on a multitude of scales. This tutorial review

emphasizes observed and inferred characteristics of the solar wind source regions. The magnetic boundary conditions in the closed corona (streamers and loops), transiently open corona (eruptive prominences or loops) and lastingly open corona (funnels and holes) will be investigated, and their influences on and consequences for the interplanetary solar wind be addressed. The resulting three-dimensional structure of the solar wind and its evolution over the solar cycle are briefly discussed.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

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Transport and Loss of Galactic and Solar Cosmic Rays in the Middle Atmosphere. Modeling the Distribution of Ionization Effects

Mateev L.[1], **Velinov P.**[1], **Ruder H.**[2], **Boshnakov I.**[1]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Institut für Astronomie und Astrophysik, Eberhard-Karls-Universität Tübingen, D-72076 Tübengen, Germany

The effects of galactic and solar cosmic rays (CR) in the middle atmosphere are considered in this work. The solar CR effects are important in the upper stratosphere, mesosphere and lower thermosphere. In fact CR determine the electric conductivity in the middle atmosphere and influence on this way over the electric processes in it. CR introduce the solar variability in the terrestrial atmosphere – because they are modulated by solar wind. A new analytical approach for CR ionization by protons and nuclei with charge Z in the lower ionosphere is developed in this paper. For this purpose the ionization losses (dE/dh) according to the Bohr–Bethe–Bloch formula for the energetic charged particles are approximated in five different energy intervals. More accurate expressions for CR energy decrease $E(h)$ and electron production rate profiles $q(h)$ are derived. The obtained formulas allow comparatively easy computer programming. The integrand in $q(h)$ gives the possibility for application of adequate numerical methods – such as Romberg method, or Gauss quadrature, for the solution of the mathematical problem. On this way the process of interaction of cosmic ray particles with the upper, middle and lower atmosphere will be described much more realistically. Computations for cosmic ray ionization in the middle atmosphere are made. The full CR composition is taken into account: protons, helium (α-particles), light L, medium M, heavy H and very heavy VH group of nuclei. The influence of solar CR from proton flare on 20 January 2005 is considered quantitatively.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

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The Response of the Earth's Magnetosphere to Changes in the Solar Wind

McPherron R.L.

Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90095-1567, USA

The solar wind couples to the Earth's magnetic field through dynamic pressure and the interplanetary magnetic field (IMF). An IMF antiparallel to the dayside field allows magnetic reconnection to interconnect the IMF and Earth's field. This process extracts energy and plasma and transports magnetic flux to the nightside. The magnetosphere returns this flux by establishing a 2-celled convection pattern and initiating reconnection in the tail. This flow brings charged particles into the inner magnetosphere energizing them in the process and forms the ring current and the radiation belts. When the IMF is fluctuating north and south magnetospheric substorms occur. If the IMS is strongly southward the ring current grows and magnetic storms are produced. If instead the IMF is weakly southward and very steady the magnetosphere responds with steady magnetospheric convection (SMC). When the IMF is steady and strongly southward sawtooth injections result. Despite the name, flow in the magnetosphere is never steady. Substorms exhibit pseudo breakups in the growth phase and poleward boundary intensifications (PBI) in the recovery phase. PBI are observed throughout both SMC and sawtooth events. Both of these phenomena are produced by transient localized reconnection. It is the strength and waveform of the solar wind drivers – dynamic pressure and electric field that determine the mode in which the magnetosphere responds. But these parameters depend on the Sun and solar wind. The geometry of the dipole and rotation axes of the Sun and Earth partly determine when the IMF will be southward. Structures in the solar wind are also important. Interfaces between high and low speed solar wind streams co-rotate with the Sun. In the interaction regions around the interface the properties of the solar wind are altered by compression and deflection of the flow. The high speed streams are filled with Alfvén waves that tip the IMF southward producing magnetic activity. Most important of all are the coronal mass ejections (CME) that produce large coherent structures that move outward from the Sun and pass the Earth. Inside many CMEs the IMF is organized as a flux rope. It is these flux ropes that produce steady southward IMF. The flux rope is often preceded by an interplanetary shock and sheath of compressed solar wind. Usually the IMF is rapidly varying in this sheath. The occurrence of CIR and CME is controlled by the 11-year sunspot cycle and the 22-year magnetic cycle of the Sun. We thus expect that the type and strength of geomagnetic activity will depend on season (location of Earth in its orbit) and phase of the solar cycles. The wide variety of modes of response of the magnetosphere to the solar wind has only recently been recognized. While we have considerable knowledge about these different modes of response we do not yet understand how the magnetosphere transitions from one to another. Neither do we know how these modes are correlated with solar wind structures. We do not know the extent to which the coupling depends on the values of solar wind parameters.

✓ PLENARY LECTURES: ORAL

EL – a Possible Indicator to Monitor the Magnetic Field Stretching at Global Scale during Substorm Expansive Phase

Meurant M.[1], **Gerard J.-C.**[2], **Hubert B.**[2], **Blockx C.**[2], **Coumans V.**[2], **Donovan E.F.**[1], **Mende S.B.**[3], **Connors M.**[4]

[1]Institute for Space Research, University of Calgary, Calgary, Alberta T2N 1N4, Canada

[2]LPAP, Université de Liège, B-4000 Liège, Belgium

[3]Space Sciences Laboratory, 7 Gauss Way, Berkeley, CA 94720-7450, USA

[4]Athabasca University, 11560 80 Avenue, Edmonton, Alberta T6G OR9, Canada

The Ion Isotropy Boundary (IB) is known to correlate well with the magnetic field inclination at geosynchronous orbit around 00 MLT and therefore provides a way to monitor the magnetotail stretching. Several ways to identify IB have been developed in the literature. Based on in situ spacecraft data, Sergeev and Gvozdevsky have defined the IB position using NOAA data and Newell et al. defined a comparable boundary (the b2i boundary) based on Defense Meteorological Satellite Program (DMSP) data. From the ground, Donovan *et al.* used Meridian Scanning Photometers (MSP) to determine the 'optical b2i' and Jayachandran *et al.* demonstrated the coincidence of the b2i and the equatorward boundary of the SuperDARN evening sector *E*-region scatter. To complement these methods, an IB determination on a wide range of Magnetic Local Time (MLT) with a high temporal resolution is useful. To do this, Trondsen *et al.* use IMAGE-FUV-SI12 imager to monitor IB by simultaneous comparison with MSP data during a 7 day period. Recently, Blockx *et al.*, have shown the potential of SI12 data for monitoring the magnetotail stretching during quiet periods. In this study, we focus our attention on the ability of SI12 to provide information on tail stretching during active periods and more specifically during the substorm expansive phase. Because of the dynamic character of expansive phases and mechanisms acting between the plasma sources and ionosphere during this phase, deducing IB position from auroral optical data is likely impossible. In order to avoid confusion between the physical meaning of IB and its role as a stretching indicator, we validate a stretching determination method using the EL indicator (determined by the Donovan's algorithm applied on SI12 data) instead of IB. For this validation, we use more than 250 isolated substorms observed by IMAGE-SI12 between 2000 and 2002. Simultaneous comparison with GOES-8 and DMSP data allows us to estimate how strong is the relation between the EL position deduced from SI12 and the magnetic field stretching. Time evolutions of the EL position are also presented for different local times during individual events.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Can the CMEs be Detected with LASCO-C1 Spectral Data?

Mierla M.[1], **Schwenn R.**[2], **Teriaca L.**[2], **Stenborg G.**[3], **Podlipnik B.**[2]

[1]Astronomical Institute of Romanian Academy, RO-75212 Bucharest, Romania

[2]Max Planck Institute for Solar System Research, D-37191 Katlenburg-Lindau, Germany

[3]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

LASCO-C1 is an internally occulted coronagraph on the SOHO spacecraft. It has a tunable Fabry–Perot interferometer which allows taking spectral scans of selected coronal emission lines. From measured line profiles we deduced physical quantities like temperature and flow velocities along the line of sight. This way, we obtained information on the flow pattern in the low corona. In particular we studied three coronal mass ejections (CMEs) taking place on the period 28th–30th of March 1998 and which could be detected by the C1 spectral data. We show in which conditions the high speed plasma can be seen by C1 images.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Solar Cosmic Rays in the System of Solar–Terrestrial Relations

Miroshnichenko L.I.[1,2]

[1]Instituto de Geofísica UNAM, Ciudad Universitaria, Del. Coyoacán, 04510 México D.F., México

[2]IZMIRAN, Russian Academy of Sciences, RU-142190 Troitsk, Russia

During solar flares the very complex events and processes occur in the nearest Earth's environment. They are due to the entire spectrum of solar ionizing radiation, including ultra-violet emission, X-rays and fast particle fluxes. In particular, over several decades an effect of polar cap absorption (PCA) of the short radio waves ($\sim$30 MHz) has been extensively studied, and this phenomena is due to additional ionization of the atmosphere (at altitudes about 30–110 km) by solar energetic protons of 10–30 MeV. There is some observational evidence of radio burst generation at ionospheric levels in the ultra-short wave range, and one of the contributors of this effect seems to be fast electrons from solar flares. There are also certain indications of an active role of galactic and solar cosmic rays (GCR and SCR) in the tropospheric processes.

Among the particle populations in the near-Earth space, of particular interest are those which possibly may be a link in the coupling of solar variability to the Earth's lower atmosphere. The solar activity control of weather and climate is a very controversial topic. However, convincing evidence of such control has accumulated, and its possible mechanisms are widely discussed. The most promising prospects in this field are bound up with the development of three possible versions of a trigger mechanism: dynamical, electrical, and optical.

Particle populations which affect the atmosphere in the most direct manner must be those which can penetrate deeply into the atmosphere. Thus, relativistic electrons appear to be among the most important candidates. Other agents of this type, also heavily dependent on solar activity, are energetic solar protons of MeV range energies. Therefore, it is necessary to consider available qualitative (theoretical) and quantitative (observational) premises of SCR influence on the geosphere, their relative role in the formation of terrestrial weather and climate.

We concentrate mainly on observational evidence and mechanisms of some expected effects and/or poor-studied phenomena discovered within 2–3 last decades: depletion of the ozone layer; perturbations in the global electric current; change of the atmospheric transparency; and production of nitrates. Some "archaeological" data on SCR fluxes in the past and upper limit of total energy induced by solar flare protons are also discussed. Due attention is paid to the periodicities in the solar particle fluxes. Actually, many solar, heliospheric and terrestrial parameters changing generally in phase with the solar activity are subjected to a temporary depression close to the solar maximum ("Gnevyshev Gap"). Similar gap has been found recently in the yearly numbers of the > 10 MeV proton events. All above mentioned findings are evidently of great importance in the studies of general proton emissivity of the Sun and long-term trends in the behaviour of solar magnetic fields. In addition, those data can be very helpful for elaboration the methods for prediction the radiation conditions in space.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

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Possibilities for Space Weather Studies at BEO Moussala – Present Status and Further Development

Mishev A.L., **Stamenov J.N.**

Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Basic Environmental Observatory Moussala, 72 Tsarigradsko Chaussee, BG-1784 Sofia, Bulgaria

The Basic Environmental Observatory (BEO) Moussala is located at 2925 m above sea level and one of the main activities is connected with environmental monitoring and cosmic ray studies. The existing devices and scientific potential of the observatory is presented precisely the experiments connected with atmospheric and astroparticle studies.

The recent results of the secondary cosmic ray measurements with Cherenkov light telescope are presented and the potential to study cosmic ray environment connection is discussed. The neutron flux meter based on SNM-15 detectors is presented and the research activities connected with the neutron measurements. The developed muon telescope based on water Cherenkov detectors is also presented. The scientific potential is discussed, precisely the connection between cosmic ray measurements and the environmental parameters. The muon hodoscope with the preliminary studies is presented, precisely several estimations and the possible design. The possibilities for space weather and atmospheric transparency are discussed.

✓ OTHER RELATED TOPICS: POSTER

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Neutron Flux Meter at BEO Moussala

Mishev A.L.[1], **Boukliyski A.L.**[1], **Visca L.**[2], **Zanini A.**[2], **Stamenov J.N.**[1]

[1]Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Basic Environmental Observatory Moussala, 72 Tsarigradsko Chaussee, BG-1784 Sofia, Bulgaria

[2]Istituto Nazionale di Fisica Nucleare Sezione di Torino, Via P. Giuria 1, I-10125 Torino, Italy

The Basic Environmental Observatory (BEO) Moussala is located at 2925 m above sea level. One of the main activities is connected with absolute neutron flux measurement which is related with environmental monitoring and cosmic ray studies. The neutron flux meter is presented in details. The simulations carried out with MCNP(x) code are presented. These simulations aiming in one hand to estimate the registration efficiency of ht neutron flux meter and the expected mean energy of the secondary cosmic ray neutron spectrum which will be registered. Moreover the simulations were on the basis for the moderator thickness estimation and therefore for the final detector design. Several measured data are presented and compared with expected theoretical results.

The research activities connected with the neutron measurements are discussed and the scientific potential especially connected with space weather is also discussed.

✓ OTHER RELATED TOPICS: POSTER

Effect of Solar Wind Parameters on Magnetopause Oscillations and Associated Geomagnetic Pulsations

Mishin V.V.

Institute of Solar-Terrestrial Physics, Russian Academy of Sciences, RU-664033 Irkutsk, Russia

We consider the Kelvin–Helmholtz instability (KHI) at magnetospheric boundary for different conditions in the magnetosheath at dayside and geotail boundaries with taking into account of the boundary layers structure for determination of instability spectra.

At dayside boundary the KHI is governed by the magnetosheath magnetic field longitude with respect to velocity direction component. It gives generation of surface (fast decreasing from the boundary) MHD waves in the range of the Pc2–Pc4 geomagnetic pulsations. Fast changes of the solar wind (SW) dynamic pressures (SSC and SI) can cause effect of the flute instability and increase the KHI growth rate. Such events may be associated with generation of wide band pulsations of the Pi1b type. SI also cause trains of the damping Pc 5 pulsations. During periodic changes of SW pressure geomagnetic pulsations can be generated via both the excitation of magnetopause oscillations by SW dynamic pressure fluctuations and MHD (KH + flute) instability.

At the distant geotail boundary KHI is developed on oblique (usually not taken into account) supermagnetosonic perturbations with amplitude, weakly decreasing in space in low frequency range (1–3 mHz) without strong dependence on the magnetosheath magnetic field, which, however, can even amplify the KHI growth rate. The build up of oblique perturbations leads to an anomalous viscosity sufficient for the formation the thick boundary layers in the distant geotail. The supersonic KHI here is favoured with taking into account the rigid-wall boundary condition.

✓ OTHER RELATED TOPICS: POSTER

Effective Solar Wind Parameters and Structures for the Evolution of the Radiation Belts

Miyoshi Y., **Kataoka R.**

Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya 464-8601, Japan

It has been well known that the primary control parameter of the evolution of magnetic storms is the southward interplanetary magnetic field (IMF). On the other hand, the flux enhancements of outer belt relativistic electrons do not always correlate with the storm size, which suggests the existence of other control parameters. It has been known that the outer belt flux enhancement is well correlated with the high-speed solar wind, while several studies have suggested that the southward IMF may also be another important parameter for the flux enhancement.

Miyoshi and Kataoka [2005] showed the dependence on large-scale solar wind structure such as CMEs and CIRs for the evolution of the outer belt. CIRs are significantly more effective for the outer belt than are CMEs. Since the fast solar wind during CMEs does not work for the flux enhancements, the solar wind speed is not a sufficient condition for the flux evolution of the outer belt. The Alfvenic fluctuations within the high-speed stream following the CIRs, which drive the HILDCAAs, are important for the evolution of the outer belt via a series of particle injections into the inner magnetosphere. On the other hand, CMEs are effective for the flux enhancement of the inner region. Only CMEs are effective for the flux enhancement at $L < 3.0$.

The outer belt moves toward the earth during the solar maximum, while it moves outward during the declining phase of a solar cycle. Kataoka and Miyoshi [2006] showed the solar cycle variation of the solar wind driver for magnetic storms: CME-driven storms occur during the solar active period, while CIR-driven storms occur during the rising and declining phase. Combining the solar wind structure dependence for the evolution of the outer belt, the long-term variation of the outer belt during the solar cycle can be explained: CMEs in the solar maximum cause the flux enhancement at the inner portion, while CIRs in the declining phase produce strong flux enhancement at the outer portion.

References

[1] Kataoka, R., and Y. Miyoshi, Flux enhancement of radiation belt electrons during geomagnetic storms driven by coronal mass ejections and corotating interaction regions, submitted to Space Weather, 2006.

[2] Miyoshi, Y. and R. Kataoka, Ring current ions and radiation belt electrons during geomagnetic storms driven by coronal mass ejections and corotating interaction regions, Geophys. Res. Lett., 2005.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Towards Developing a Ground-Based Coronal and Heliospheric Plasma Diagnostic

Moise E.[1], **Kuhn J.**[1], **Raymond J.**[2]

[1]Institute for Astronomy, University of Hawaii, Honolulu, HI 96822, USA

[2]Harvard-Smithsonian Center for Astrophysics, Cambridge, MA 02138, USA

Cool neutral Helium is now being observed near the Sun. From eclipses, and routinely from sensitive IR spectropolarimetry data using SOLARC at Haleakala, observations reveal scattered photospheric light at 1083 nm from He I far above the solar limb. Eclipse measurements probe He I to more than 2 solar radii projected distance, while the coronagraph data can reliably measure it to about 1R beyond the limb. These unique data have been interpreted and reported here. Our preliminary calculations suggest that a hot coronal He I component may also be visible in refined, higher sensitivity SOLARC spectropolarimetry. In this paper, we discuss the physical implications of 'coronal' He I Measurements.

✓ OTHER RELATED TOPICS: POSTER

On the Association between Northward Turnings in the IMF and Substorm Onset

Morley S.K.[1], **Freeman M.P.**[2]

[1]School of Mathematical and Physical Sciences, University of Newcastle, Newcastle, NSW 2308, Australia

[2]Physical Sciences Division, British Antarctic Survey, High Cross, Cambridge CB3 0ET, UK

Whether magnetopsheric substorms are triggered by external solar wind fluctuations or an internal magnetospheric instability is unresolved. We present a large statistical survey of interplanetary magnetic field (IMF) data and determine the occurrence frequency of external substorm triggers (northward turnings) as defined by Lyons (1997). We examine the association between these external triggers and substorm onsets and show that prior loading of energy, common to both triggered and untriggered models, is required for substorm onset. This leads to a larger number of trigger signatures than expected by chance being observed around substorm onset. Thus the previously reported associations between substorm onset and IMF trigger signatures can be explained by the necessity of a growth phase for substorm onset, and the inclusion of a growth phase requirement in the trigger definition. We discuss the impact of this result on previous conclusions, including claims that triggered substorms are systematically larger than untriggered substorms.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Long-Term Behavior of Energetic Particle Fluxes at Low L-Shells and their Relation to the South Atlantic Anomaly

Asikainen T., **Mursula K.**

University of Oulu, FIN-900014 Oulu, Finland

A recent study by Asikainen and Mursula (2005) showed that, at least during great magnetic storms, the South Atlantic Anomaly (SAA) can reduce the eastward drift speed of energetic electrons at low invariant latitudes, leading to their effective trapping within the SAA region. Here we study energetic particle fluxes observed within the SAA region during a period of a few months using data from the low-altitude NOAA-15 and 16 satellites. Observations by these two spacecraft can yield long-term measurements of energetic particle fluxes at four different local time sectors. We will discuss the time development and local time dependence of energetic electron and proton fluxes inside and outside of the SAA region. Moreover, we will study the dependence of these fluxes on global geomagnetic activity (measured by the Kp index) and the ring current intensity (Dst/Dcx index). We will study, *e.g.*, if the trapping of energetic electrons within the SAA only occurs during great magnetic storms or if it is a more general feature of the SAA region.

T. Asikainen and K. Mursula, Filling of the South Atlantic Anomaly by energetic electrons during a great magnetic storm, *Geophys. Res. Lett.*, Vol. **32**, L16102, doi:10.1029/2005GL023634, 2005

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Correcting the *Dst* Index: Consequences for Absolute Level and Correlations

Karinen A., **Mursula K.**

University of Oulu, FIN-900014 Oulu, Finland

The Dst index has been shown to include an excessive, seasonally varying quiet-time level, so called 'non-storm component' which is unrelated to the intensity of the ring current or magnetic storms. We have recently proposed a corrected and extended version of the Dst index, the so called Dcx index. Here we discuss the properties of the Dcx index, and the consequences of replacing the Dst

index by the more correct Dcx index. We show that this correction can raise the Dst values by up to 44 nT for individual storms. The average increase of the Dst index is 6.0 nT for all SSC storms in 1932–2002 (5.7 nT in 1932–1956 and 6.1 nT in 1957–2002), implying a correction of about 23% to the average 7-day storm level, and a 14% correction to the average minimum-Dst value of 42.3 nT for all SSC storms. This correction is large enough to affect most previous storm studies and even the classification of storms to the different intensity levels. The correction has a strong seasonal variation with maxima around the equinoxes, especially in the vernal equinox. The largest monthly correction of about 12 nT is found for March. We also verify that the main phase of an average storm is less intense and the recovery phase is longer in the early period (1932–1956) than in the later period (1957–2002), supporting the idea that storms in the early period were more typically driven by high-speed streams rather than by strong CMEs. Moreover, we show that the correction of the Dst index improves its correlation with both sunspots and geomagnetic indices. Thus, conclusions based on correlating Dst with sunspots or geomagnetic indices need to be revised using the Dcx index.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Heliospheric Magnetic Field: The Bashful Ballerina Dancing in Waltz Tempo

Mursula K.

University of Oulu, FIN-900014 Oulu, Finland

The recent developments in the long-term observations of the heliospheric magnetic field (HMF) observed at 1 AU have shown that the HMF sector coming from the northern solar hemisphere systematically dominates in the late declining to minimum phase of the solar cycle. This leads to a persistent southward shift or coning of the heliospheric current sheet at these times that can be picturesquely described by the concept of the Bashful Ballerina. This result has recently been verified by direct measurements of the solar magnetic field. The average field intensity is smaller and the corresponding area is larger in the northern hemisphere. Also, ground-based observations of the HMF sector structure extend these results to 1920s. Moreover, it has been shown that the global HMF has persistent active longitudes whose dominance depicts an oscillation with a period of about 3.2 years. Accordingly, the Bashful Ballerina takes three such steps per activity cycle, thus dancing in Waltz tempo. Stellar observations show that this seems to be a general pattern for sun-like cool stars. We describe these phenomena and discuss their implications.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Two Fluid Equations Model for Coronal Heating and Solar Wind Acceleration

Naitamor S., **Abdelatif T.E.**

Centre de Recherche en Astronomie, Astrophysique et Géophysique. Chemin de l'Observatoire, BP 63,
Bouzaréah 16340, Algeria

In this contribution we will present numerical results of two fluid equations of coronal heating and solar wind acceleration from 1 Rs to 1 AU. The equations used are the standard hydrodynamic for the electrons and the protons where we assume that the electrons are responsible for energy transfer to the protons by coulomb process in the collision region. The initials conditions (for particle density and temperature) are similar to the chromosphere conditions. The results show that the proton temperature increase up to 3×10^6 K in the coronal region but the electron temperature shows small increasing behavior may be due to the to the used assumption. Beyond the coronal distance the species temperatures decrease with distance to the ambient values. Plasma speed increases from the sun surface up to the asymptotic value 400 km/s.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

A New Technique for Quantifying the Eruptive Potential of Solar Active Regions from Photospheric Vector Magnetograms and Its Utilization in Simulations of the Sun–Earth System

Nandy D., **Canfield R.C.**

Department of Physics, Montana State Univeristy, Bozeman, MT 59717, USA

The properties and dynamics of magnetic fields on the Sun's photosphere, notably those within solar active regions, ultimately govern the eruptive activity of the Sun. These photospheric magnetic fields also act as the lower and governing boundary of the Sun–Earth coupled system. Understanding the physical attributes of solar magnetic fields and their impact on the near-Earth Space environment is therefore vital for mitigating its adverse Space Weather effects. In this context, we present a new technique for quantifying an important

attribute of solar active regions from photospheric vector magnetograms, namely, the twist in its magnetic field lines. Twist in solar active regions is known to play a crucial role in flaring activity and the initiation of CMEs via the kink instability mechanism and we outline a procedure for determining this eruptive potential of active regions using our technique. We also discuss how twist in the photospheric magnetic fields can be used as inputs in simulations of the solar coronal and heliospheric fields that ultimately govern the Sun–Earth system.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Application of DFA Method to Magnetic Field Data from SEGMA Array

Nenovski P.[1], **Chamati M.**[1], **Schwingenschuh K.**[2], **Boudjada M.**[2], **Vellante M.**[3], **Villante U.**[3], **Wesztergom V.**[4]

[1]Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Space Research Institute, Austrian Academy of Sciences, A-8042 Graz, Austria

[3]Department of Physics, University of l'Aquila, I-67100 l'Aquila, Italy

[4]Geodetic and Geophysical Research Institute, Hungarian Academy of Sciences, H-9400 Sopron, Hungary

We apply DFA method to magnetic field data from SEGMA array for the period August 2004 – February 2005. The SEGMA meridional array is a set of stations mainly localized in the Adriatic region (at a longitude of about 13° E) and devoted to the magnetic field measurements in the ULF frequency range. We study the fluctuation function and the corresponding DFA scaling exponent which characterize the long-range correlations in magnetic field data series recorded by Italy and Hungary stations. For each station we consider both the similarity and the differences in the DFA index behavior. Changes in the strength of the long-range correlations in different time scales – from seconds to months – are reported. The similarity in the DFA trends is associated mainly with the global geomagnetic activity. The disparities consist in the variable level of the DFA index value from different stations and an emergence of specific decreases of the DFA index (intervals of a lost of long-range correlations) at individual station that last at least several days. The probable origin of such DFA index behavior is found to be related to local processes of similar characteristics both in the atmosphere/ionosphere system and/or in the lithosphere.

✓ OTHER RELATED TOPICS: POSTER

Ten Characterizations of the Magnetosphere, Twenty Coupling Functions

Newell P.T., **Sotirelis T.**, **Liou K.**, **Meng C.-I.**

Applied Physics Laboratory, Johns Hopkins University, Laurel, MD 20723, USA

We correlated ten magnetospheric state variables, including five planetary global magnetic indices (Kp, Dst, AE, AU, and AL) and five spacecraft-based indices (cusp latitude from DMSP, global auroral power from Polar UVI, the b2i magnetotail stretching index, GOES inclination angle, and the size of the polar cap from OVATION) with twenty candidates for the solar wind-magnetosphere coupling function. Out of the many functions that have been proposed and commonly encountered in the literature, two consistently worked best. These two are the Kan–Lee electric field ($E_{\text{KL}} = vB_{\text{T}}\sin^2(\theta_c/2)$) and a function intermediated between the half-wave rectifier and the Kan–Lee electric field, namely $E_{\text{WAV}} = vB_{\text{T}}\sin^4(\theta_c/2)$. The latter works better for most state variables, including the latitude of the cusp, AE, and Dst. Thus all these seemingly disparate variables, apparently describing quite different aspects of the magnetosphere, respond to the same solar wind input function, albeit on much different time scales. A few magnetospheric state variables, including Kp and b2i respond slightly better to the Kan–Lee electric field, with E_{WAV} second. Indeed, Kp and magnetotail stretching correlate at the same level with the same input functions, and even exhibit the same time optimal time integration of the solar wind (about 6 hours). These results can be used to infer the global merging rate as a function of IMF cone angle. Specifically, they indicate merging for small IMF cone angles is much faster than the half-wave rectifier function would permit, and probably slower than the Kan–Lee electric field implies.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Verification of Storm-Time Electric Field Models by Particle Tracing and Auroral Oval Prediction

Nowakowski R., **Bojanowska, M.**

Space Research Center, PAS, Bartycka 18A, PL-00 716 Warsaw, Poland

Magnetospheric electric field models can be constructed by tracing ionospheric potential along field lines. This procedure is applied to empirical models. Particle motion in dynamical storm-time electric and magnetic field models is studied, with particular emphasis on

the auroral oval prediction. Comparison of predicted and observed ovals for strong magnetic storms can then be a test for electric field model applicability during extremely disturbed conditions.

✓ Sun–Earth System Modeling and Prediction: POSTER

The Role of Large-Scale Magnetic Fields in the Sun–Earth System: Some Results of the ISCS Project

Obridko V.N.

Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Russian Academy of Sciences,
RU-142190 Troitsk, Russia

The origin of large-scale magnetic fields (LSMF) and their coupling to the local fields are being discussed. Helioseismic data have been used to investigate the problem of generation of LSMF with allowance for their meridional drift. The LSMF data prove to be of fundamental importance to the long-term (5–11 years) forecast of solar activity. It was shown that the heating of the solar corona can be simulated taking into account the LSMF intensity and structure. It was also shown that the solar wind comprises different types of the streams, whose relative contribution changes with the phase of the cycle. Specific conditions have been studied in the regions of occurrence of coronal mass ejections. The concept that the B_z component is transported through interplanetary space has been confirmed. The solar activity is predicted to decrease during the first third of the current century.

✓ Solar Dynamics and the Response of Geospace: ORAL

Response of the Lower Ionosphere to Solar Proton Event on July 14 2000. Model Simulations over Both Poles

Ondrášková A.[1], **Krivolutsky A.A.**[2], **Kuminova A.**[2]

[1]Department of Astronomy, Physics of the Earth & Meteorology, Faculty of Mathematics, Physics and Informatics, Comenius University, SK-842 48 Bratislava, Slovakia

[2]Central Aerological Observatory, RU-141700 Dolgoprudny, Russia

Response of the neutral middle atmosphere and ions in lower ionosphere to one of the strongest Solar Proton Events (SPE) has been studied with the emphasis on the difference over the North and South Pole. 3D general circulation and chemical global transport-photochemical middle atmosphere model have been used for simulations of neutral composition, wind and temperature response to one of the strongest SPE of the 23 rd solar cycle: 14 July 2000. It was assumed in the photochemical scheme that approximately one molecule of NO and two molecules of OH are produced for each pair of ions that are created by particles. SPE-induced ionization rates have been calculated using high time-resolution satellite measurements of solar proton fluxes provided by GOES. Concentrations of the short-living ions in the lower ionosphere have been calculated using the calculated SPE-induced neutral atmosphere composition and 1D photochemical model of lower ionosphere. Results of simulations will be presented.

✓ Sun–Earth System Modeling and Prediction: POSTER

Who Needs Predictions of the Sun–Earth System?

Onsager T.

NOAA Space Environment Center, Boulder, CO 80305, USA

An important challenge for solar-terrestrial physics research is to advance our understanding of the Sun–Earth system and to develop models to the level where timely and accurate predictions of space weather can be made that result in benefits to society. For this to occur, the information provided by these models must be directly usable and must enable decisions to be made that have positive economic consequences. Although much of what is needed today for important applications, such as forecasts of solar energetic particle events, is well beyond the scope of current scientific capabilities, progress is being made in many areas that could lead to direct benefits. This presentation will focus on our current understanding of the specific needs for space weather information and the current capabilities of our scientific models. We will explore the overlap between emerging scientific capabilities and space weather needs.

✓ Sun–Earth System Modeling and Prediction: ORAL

Investigation of the Solar Cycle Variation of *fo*F2 by Using Solar Flare Index for the Cycles 22 and 23

Ozguc A., **Atac T.**, **Pektas R.**

Kandilli Observatory and E.R.I., Bogazici University, Cengelkoy, TR-34684 Istanbul, Turkey

For solar activity cycles 22 and 23 (1986–2006) the variation of monthly mean values of noon-time foF2 at Slough, Rome and Manila are investigated by using solar flare index and geomagnetic Ap index. A single regression analysis for dependence of foF2 on solar flare index shows better matching. Moreover, less hysteresis effect is seen when we use solar flare index instead of other solar activity indices. Thus, for making prediction one needs to take into account only the solar flare index and not the solar flare index and geomagnetic Ap index simultaneously.

✓ Solar Dynamics and the Response of Geospace: POSTER

Solar EUV/XUV Irradiance Variations and Eruptive Events

Pap J.[1], **Turmon M.**[2], **McMullin D.**[3], **Floyd L.**[4]

[1]Goddard Earth Science and Technology Center, University of Maryland, Baltimore County, Baltimore, MD 21228, USA

[2]Jet Propulsion Laboratory, CALTECH, Pasadena, CA 91109, USA

[3]Praxis, Inc., Space Sciences Center, University of Southern California, Los Angeles, CA 90089, USA

[4]Interferometrics, Inc, Herndon, VA 20171, USA

Measurements of the solar EUV irradiance in the 1–50 nm range and in the vicinity of 30.4 nm have been conducted by the Solar EUV Monitor (SEM)/CELIAS experiment on SOHO since December 1995, providing the first continuous EUV observations covering a solar cycle. The SEM EUV observations show that EUV irradiance has strong variable components associated with the 11-year solar cycle, the 27-day solar rotation and also shows rapid variations related to solar flares. In this paper we examine in detail the variations in EUV irradiance compared to solar activity features (sunspots, faculae and network) as derived from the magnetograms and photograms taken by the Michelson Doppler Imager on SOHO. The GOES soft X-Ray data are used to establish the association between the rapid changes in the SEM EUV/XUV irradiance and solar flares, especially the ones accompanied by CMEs.

✓ Other Related Topics: POSTER

The Population of the Magnetotail by Solar Wind and Ionospheric Plasmas during the September 24–25, 1998 Magnetic Storm

Peroomian V.[1], **El-Alaoui M.**[1], **Ashour-Abdalla M.**[1], **Zelenyi L.M.**[2]

[1]UCLA-IGPP, Los Angeles, CA 90095-1567, USA

[2]Space Research Institute, RU-117997 Moscow, Russia

We have used a global time-dependent magnetohydrodynamic (MHD) simulation of the magnetosphere and particle tracing calculations to determine the access of solar wind ions to the magnetosphere and the access of ionospheric O^+ ions to the storm-time near-Earth plasma sheet and ring current during the September 24–25, 1998 magnetic storm. The MHD simulation was initiated with solar wind data obtained from the WIND spacecraft for this event. To study solar wind entry, we launched ions upstream of the bowshock with the solar wind streaming velocity and thermal spread, and followed the particles through detectors placed within the magnetopause current layer. This allowed us to gain a better understanding of the transport and acceleration of solar wind plasma during this storm. To gauge the contribution of ionospheric plasmas, we traced a large number of particle orbits from the dayside ion fountain. Ion launches from both sources were carried out at five minute intervals beginning prior to the arrival of the sudden impulse and continuing for the first eight hours of the storm. Ion outflow rates were normalized with empirical models as well as in-situ observations from WIND and POLAR/TIDE. This allowed us to assess the time-dependent access of solar wind H^+ and ionospheric O^+ ions to the magnetosphere during the storm, their energization in the magnetotail current sheet, and their loss from the magnetosphere.

✓ Production, Transport, and Loss of Energetic Particles: ORAL

ULF Turbulence Indices for the Space Weather

Pilipenko V.[1], **Khabarova O.V.**[1], **Romanova N.**[2]

[1]Space Research Institute, RU-117997 Moscow, Russia

[2]Institute of the Physics of the Earth, RU-123995 Moscow, Russia

The solar wind-magnetosphere interaction has most probably a turbulent character, which is not accounted for by commonly used geomagnetic indices and OMNI parameters. To quantify the level of low-frequency turbulence/variability of the geomagnetic field,

IMF, and solar wind plasma, we have introduced ULF wave power indices. These simple hourly indices are based on the band-integrated spectral power in the range 2–7 mHz. The ground geomagnetic wave index has been produced from the data of global magnetometer arrays in the northern hemisphere. The interplanetary wave index has been calculated using magnetometer and plasma data from Wind or ACE satellites. These indices have turned out to be useful for statistical analysis of various space weather problems.

For example, the enhancements of relativistic electrons at the geosynchronous orbit were not directly related to the intensity of magnetic storms, but they correlated well with intervals of elevated ULF wave index. This comparison confirmed the importance of magnetospheric ULF turbulence in energizing electrons up to relativistic energies.

To characterized the IMF and solar wind plasma fluctuations with time scales of ~10–100 min we have introduced the index based on the band-integrated wavelet power. We applied this index to the analysis of conditions in the solar wind before magnetic storm onsets for the period from solar minimum (1995) to solar maximum (2000). It was found that a weak increase of density is observed on average 2 days prior to storm commencement for a dominating number of magnetic storms of different origin. This plasma increase before magnetic storms is irregular and accompanied by enhanced solar wind density fluctuations with time scales ~4–120 min. Thus, variations of the solar wind plasma are a largely underestimated factor in magnetic storm triggering and could be effectively used for space weather forecasting.

In addition to the presented problems, a wide range of space physics and geophysics studies will benefit from the introduction of the ULF wave indices. The ULF index database is freely available via anonymous FTP for all interested researchers for further validation and statistical studies.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Solar Corona Expansion and Heliospheric Current Sheet Creation

Podgorny I.M.[1], **Podgorny A.I.**[2]

[1]Institute for Astronomy, RAS, 48 Pyatnitskaya Street, RU-119107 Moscow, Russia

[2]Lebedev Physical Institute, RAS, 53 Leninsky Prospect, RU-119991 Moscow, Russia

Solar corona expansion and heliospheric current sheet creation have been investigated by numerical solution of 3D MHD equations, using the Peresvet code. The finite-difference scheme is absolutely implicit and conservative relative to magnetic flux. The dipole magnetic field is corresponding to the solar magnetic field at the activity minimum. Typical corona parameters are used as initial conditions. Plasma compression, dissipation, thermal conductivity, and gravitation are taken into account. The anisotropy of thermal conductivity in the magnetic field is also taken into account. The results of calculation demonstrate that at the beginning of corona expansion the density gradient and the temperature gradient are very sharp at the boundary, and the pressure gradient is much bigger than gravitation force. Coronal plasma expansion disturbs the magnetic field of solar dipole and creates a current sheet in the equatorial plane. Magnetic field lines stretched due to plasma expansion. In the ring current generated at radial solar corona expansion in the magnetic field the charges move freely under Lorenz force action, and polarization does not appear. As a result, the current density becomes as $\boldsymbol{j} = \sigma \boldsymbol{V} \times \boldsymbol{B}/c$. There are no opened field lines in this configuration, all lines connect North and South hemisphere. All lines cross the current sheet, *e.g.* current sheet posses the normal magnetic component. The sheet is not a neutral one. The normal magnetic field component plays a decisive role in the current generation. The current generation is similar to action of a short closed MHD generator. The solar wind temperature is determined by plasma cooling because of plasma expansion and heat conduction from the Sun. In the process of expansion the solar wind is accelerated. The velocity increases with distance from the Sun and achieves the supersonic velocity at a distance of about 3 solar radii. There are no discontinuities appeared near this point. The stationary plasma flow is very sensible to corona parameters. The similar effect exists in the Parker solution. It is shown that the upper limit of the solar wind conductivity is determined by the current velocity limit. In regions of high electric field, such as HCS, the real solar wind conductivity can be order of 10^{-6} of Spitzer conductivity. As a result the heliospheric current sheet thickness is not thinner than $\sim 10^7$ cm. The current sheet is located inside the rather broad plasma sheet. Solar wind velocity is dropped inside the sheet because of braking by $\boldsymbol{j} \times \boldsymbol{B}$ force. The similar situation is revealed in the space measurements.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

The Flare and Coronal Mass Ejection Electrodynamical Model

Podgorny I.M.

Institute for Astronomy, RAS, 48 Pyatnitskaya Street, RU-119107 Moscow, Russia

The flare electrodynamical model is proposed on base current sheet creation in corona above the active region. The model explains flare and coronal mass ejection production. It is shown that the energy order of 10^{32} erg is accumulated in the current sheet magnetic field during 1–2 days before the flare. The current sheet creation takes place due to MHD disturbances arriving from the photosphere and focusing around a singular line, or due to new magnetic loop emergence near a pre-existing loop, if the polarity of the new loop is opposite to that of the old loop. In the simples case the singular line is a zero X-type magnetic line. Both mechanisms are demonstrated

in 3D numerical simulation. The current sheet stability is supplied by plasma flow along the sheet and existence the normal magnetic field component. The current sheet becomes unstable after quasistationary evolution and decays due to fast magnetic reconnection. If a vertical current sheet decays, the plasma ejected in the interplanetary space by magnetic tension produces a coronal mass ejection. In that case the solar flare and CME appear in the same explosive event. Simultaneously appearance a flare and CME is demonstrated. Plasma accelerated downward produces post flare loops. The plasma heating during fast reconnection produces X-ray emission in corona. This thermal X-ray emission above the active region at a flare development has been demonstrated by Yohkoh and RHESSI missions. The position of a current sheet above the active region coincides with the maximum of the brightness temperature obtained from emission of radio continuum. Spectra solar cosmic rays obtained from neutron monitors correspond to proton acceleration in the Lorenz electric field directed along a singular line. The important feature of a current sheet is the normal magnetic component. Its existence leads to Hall electric field $E = j/nec$ appearance and field-aligned currents generation. The upward and downward field-aligned currents are closed in the chromosphere. The electrons accelerated in upward field-aligned currents produces sources of hard X-ray emission in the leg foundations of a postflare loop. Legs of a loop move apart during fast reconnection. This phenomena usually observed in visible radiation as ribbons. The mechanism of ribbons and X-ray emission reminds aurora production where precipitating electrons gain their energy in potential drops (double electric layers or regions of anomalous resistivity) along upward field-aligned currents. The possibility of Hall electric field generation in a current sheet has been for the first time demonstrated by measurements of electric and magnetic fields in the region of the Earth magnetosphere field-aligned currents on the Interkosmos-Bulgaria-1300. There are many similarities in development of flare and substorms.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

The Numerical MHD Simulation of Solar Flares

Podgorny A.I.

Lebedev Physical Institute, RAS, 53 Leninsky Prospect, RU-119991 Moscow, Russia

The current sheet creation above the real active region of solar corona is simulated numerically. The Peresvet code is developed for solving full system of dissipative 3D MHD equations for compressible plasma. The anisotropy of thermal conductivity in the magnetic field is taken into account. Calculations are carried for several real active regions for real magnetic disturbances that appear in 2–3 days before the flare. As an initial condition the potential magnetic field above the active region is used that is calculated from the line of the sight magnetic field measured on the photosphere with SOHO. In all previous publication the active region magnetic field is approximated by magnetic charges or dipoles. No assumptions are introduced about appearing some special type of disturbances in the active region (currents, ropes or curls). The finite-difference scheme is absolutely implicit and conservative relative to magnetic flux. It is solved by the iteration method. To accelerate calculations the multilevel time-step reduction in the places of strong values gradients is used. Near the region boundary, where the numerical instabilities especially strong, the artificial viscosity is introduced and some other special methods are used. To use effectively the conservative relative to the magnetic flux difference scheme for obtaining the stable solution of MHD equations, the Laplace equation is solved numerically on the same grid as for the MHD equations scheme. For this purpose the potential magnetic field is found in such approximation, that finite-difference analogs of rot$\boldsymbol{B}$ and div$\boldsymbol{B}$ on this grid are equal zero with very high precision. It shown, that the main condition for current sheet creation is a singular line existence in the corona. Current sheet creation takes place around this singular line. The important role in dynamics of a current sheet plays the normal magnetic field component. Coronal plasma inflows into the current sheet due to magnetic reconnection and is accelerated by $\boldsymbol{j} \times \boldsymbol{B}/c$ along the sheet. Interaction of the downward super Alfvénic plasma flow with a magnetic loop produces fast shock wave. The current sheet stability during energy accumulation and fast energy release during a flare are considered. The results of numerical simulation open possibility for solar flare prognosis. The numerical simulation of flares (30.05.1991, Bastille flare 14.07.2000, and 27.05.2003) and comparison with observation data are presented. The Peresvet code is used also for simulations of other solar phenomena such as X-ray bright points, solar corona thermal expansion in space and heliospheric current sheet creation.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

The Evidence of Energy Release in a Current Sheet during the Flare May 27, 2003

Podgorny A.I.[1], **Podgorny I.M.**[2], **Meshalkina N.S.**[3]

[1]Lebedev Physical Institute, RAS, 53 Leninsky Prospect, RU-119991 Moscow, Russia

[2]Institute for Astronomy, RAS, 48 Pyatnitskaya Street, RU-119107 Moscow, Russia

[3]Institute for Solar-Terrestrial Physics, SO RAS, 126a Lermontov Street, RU-664033 Irkutsk, Russia

The strongest increasing of the radio emission bright temperature among flares of May 27, 2005 is observed at 02:53:28.54. The results of numerical 3D MHD simulation of this phenomenon are presented. The calculations carried out for the active region AR 0365 show solar flare energy accumulation with current sheet creation in the vicinity of a singular line. Photospheric magnetic maps are used in the PERSVET code for setting boundary conditions. As an initial condition the potential magnetic field above the active region is used that

is calculated from the line of the sight magnetic field measurement. For this reason magnetic components parallel to the photosphere are taken from distribution of the potential magnetic field that is obtained in calculations using the photospheric line of sight component. For this purposes Laplace equation is solved with an inclined derivative as a boundary condition. The evolution of the preflare photospheric magnetic field produces magnetic disturbances responsible for current sheet creation. The current sheet production is not associated with a magnetic rope or other special magnetic structures appearing. The results of calculation are compared with distribution of the radio-emission brightness temperature obtained by observations on the SSRT radio telescope (Irkutsk). The radio emission is measured at wave length $= 5.2$ cm corresponding to plasma frequency at the density $\sim 10^{10}$ cm^{-3}. This emission belongs to continuum that appears during a flare at < 30 cm and associate with hard X-ray. The position of radio emission maximum coincides with maximum current density better than 1o. This result demonstrates that current sheet decay in corona is responsible for energy release during a flare. The possibility appears to use MHD simulation for essential increase of solar flare prognosis quality.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Relation between Maximum Amplitude of Sunspot Cycle and Sunspot Numbers during Declining Phase of Previous Cycle

Podladchikova T.[1], **Lefebvre B.**[2], **van der Linden R.**[3]

[1]Institute for Applied System Analysis, National Technical University of Ukraine, UA-03056 Kiev, Ukraine

[2]Blackett Laboratory, Imperial College London, London SW7 2BW, UK

[3]Solar Influences Data Analysis Center, Royal Observatory of Belgium, B-1180 Brussels, Belgium

Two features are found in the temporal behavior of the decaying part of the 11-year solar cycle as described by 13-month averaged sunspot number time-series, which may help to predict the magnitude of the next solar cycle. Slow decline or even rapid variations and jumps during declining phase which oppose to the global decrease are viewed as a prelude to a stronger rise of activity during the next cycle. Such variations cause an increase of the ‘integral activity’ as determined by the area delimited by the sunspot numbers and a uniformly declining curve. Conversely, a too high rate of decline causes a decrease of the integral activity.

We demonstrate a clear relation between the maximum amplitude of sunspot cycle and features of this integral activity in declining phase of previous cycle. Two relevant indicators were constructed from these features. The first determines if the amplitude of the next cycle will be larger or smaller compared to the current one and is validated by a perfect agreement for all of cycles from 1 to 23. The second is used to get quantitative predictions about the next cycle’s maximum sunspot number during modern era (cycles 10–23). The predictions for increasing maximal amplitudes (cycles 11, 13, 15, 17, 18, 19, 21) are determined with relative errors from about 1% to 14% when using data up to the start of the next cycle. Concerning the cycles with decreasing amplitudes relative to the previous ones (cycles 12, 14, 16, 20, 22, 23) we estimate an upper bound for their magnitude, which can be better determined as the cycle progresses.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Fast CME Simulations: Initiation, IP Evolution and Impact

Poedts S., **van der Holst B.**, **Romashets E.**, **Jacobs C.**, **Chané E.**, **Dubey G.**

Center for Plasma Astrophysics, Department of Mathematics, KU Leuven, Celestijnenlaan 200B, B-3001 Leuven, Belgium

The term “Space Weather” refers to conditions on the sun and in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health. The effects of Space Weather on human activity are numerous including geomagnetically induced currents (GICs) flowing in power transmission lines, oil and gas pipelines, telecommunication cables, railway equipment and even long bridges, thereby causing problems for the normal operation of these systems. The high current peaks can damage or even destroy transformers and increase corrosion of pipelines. The magnetic storms change the structure of the ionosphere affecting the propagation of UHF and VHF waves and causing distortions or even failures of telecommunication and navigation (GPS) systems. Moreover, these frequent storms yield high doses ionizing radiation that can seriously damage the health of e.g. astronauts and aircraft crew.

Coronal Mass Ejections (CMEs) are the most prominent solar drivers of the space weather. During a CME huge amounts of mass (typically 10^{12}–10^{13} kg) are ejected into the corona at velocities of typically 400 km/s, although the CME velocity can be as high as 2000 km/s and sometimes even higher. The fast CMEs give rise to shock waves in which charged particles are accelerated. These energetic particles are responsible for the most destructive effects of space weather on Earth. The strong MHD shocks and magnetic clouds related to fast CMEs in the solar corona and interplanetary (IP) space thus play an important role in the study of space weather. Better predictions or forecasts of space weather and magnetic storms require a deeper insight in the physics behind it. Therefore, numerical simulations of CME initiation, IP evolution and impact models are performed.

The studied CMEs are generated with different kinds of initiation models, viz. foot point shearing, magnetic flux emergence/cancellation and simple density-driven CMEs. The effect of the initiation parameters, like the shear velocity, the extent of

the shear region, the amount and the emergence rate of the magnetic flux, *etc.*, on the early and IP evolution of the CMEs is studied. Another important aspect of our study is the fact that we do the same CME simulations superposed on three different models for the background solar wind: a polytropic wind model, the MHD wind model developed by the Michigan group, and the Alfvén wave pressure driven wind model developed by the San Diego group. The simulations, however, are done with the same code, the same numerical technique, the same boundary and initial conditions, and on the same numerical grid. This enables us to objectively quantify the effects of both the CME parameters (*e.g.*, the initiation mechanism, the presence of a magnetic flux rope and the polarity of this flux rope, *etc.*) and of the background solar wind model on the CME evolution and impact parameters, such as the velocity, the acceleration, the propagation direction, the shock formation and the topology of the generated IP shock, as well as the followed trajectory and interaction with the magnetospheric bow shock and, thus, the geo-effectiveness of the CME induced magnetic storms. The most recent results of these studies will be presented and discussed.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Database of ELF-VLF Plasma Wave Activity in Earth's Radiation Belts

Pokhotelov D., **Lefeuvre F.**

LPCE-CNRS, F-45071 Orleans Cedex 2, France

The new database of various plasma wave modes observed within Earth's radiation belts has been constructed based on datasets of different spacecraft (DE-1, Cluster, POLAR). The spatial distributions of spectral density of magnetic and electric field components observed in the ELF–VLF frequency range allow to compare relative importance of various plasma wave phenomena (equatorial electromagnetic emissions, plasmaspheric hiss, chorus, VLF transmissions, etc.) for the wave–particle interaction processes. Unlike previous developments the new database contains spectral densities as a function of local plasma gyrofrequency that improve the identification of wave phenomena and simplify the compilation of data coming from different spacecraft. The database is designed as a tool for the computation of particle diffusion coefficients that are utilized in physical radiation belt models.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

Solar Cycle Variations and Cosmic Rays

Potgieter M.S.

Unit for Space Physics, School of Physics, North-West University, Potchefstroom 2520, South Africa

Cosmic rays are excellent indicators of the various solar cycle variations. Galactic and anomalous cosmic rays encounter an outward-moving solar wind with ever-present magnetic field fluctuations and turbulence, which constitutes the convection and diffusion processes in the heliosphere. They also lose energy as they diffuse, and drift inward or outwards, the latter because of the current sheet, global curvature and gradients in the heliospheric magnetic field. As a result the intensity of cosmic rays directly reflects the various solar cycle variations, from the well-known 11 and 22 year cycles, with the reversal of the solar magnetic field at extreme solar maximum, to highly temporal variations like proton flares, Forbush decreases, corotating interaction regions, and a variety of propagating diffusion barriers. All these features contribute and influence space weather at Earth. Recently, the importance of the time-dependent extent (modulation volume) and the dynamics of the heliosphere, in particular the role of the heliosheath and the location of the heliopause, have been emphasized as important to the long-term space climate of the solar system. The compound time-dependent approach in studying solar cycle variations with cosmic rays in the heliosphere will be reviewed.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

An Effort to Derive a Convection Electric Field Model in the Inner-Magnetosphere Using Cluster EDI and EFW Data

Puhl-Quinn P.A.[1], **Matsui H.**[1], **Jordanova V.K.**[2], **Khotyaintsev Y.**[3]

[1]University of New Hampshire, Durham, NH 03824, USA

[2]Los Alamos National Laboratory, Los Alamos, NM 87545, USA

Swedish Institute of Space Physics, Uppsala, PO Box 537, SE-751 21 Uppsala, Sweden

We investigate the morphology and dynamics of the convection electric field (CEF) in the inner-magnetosphere using measurements from the two electric field experiments on Cluster: the Electron Drift Instrument (EDI) and the Electric Fields and Waves Experiment (EFW). In the inner-magnetosphere, the EDI and EFW data sets support each other due to complementary strengths and weaknesses

of the measurement techniques. Merging of the two data sets produces a superset of electric field data which is superior to either one alone. This CEF data superset, comprising data from 2001 to present, will be used to construct a parameterized, equatorial CEF model. Suitable parameterization schemes based on solar wind parameters are investigated. Ideally, the equatorial CEF model will extend from $L = 2$ to 10, a particulary useful representation for studying the evolution of the storm-time ring current and associated sub-auroral magnetosphere-ionosphere (M-I) coupling phenomena.

✓ CLUSTER OBSERVATIONS AND THEORY: POSTER

Large-Scale Solar Wind–Magnetosphere Coupling

Pulkkinen T.I.

Los Alamos National Laboratory, MS D466, Los Alamos, NM 87545, USA

While the solar wind and interplanetary magnetic field power magnetospheric activity, the magnetosphere is by no means a passive element in determining the dynamic state of the system. Recent simulation results suggest that the energy input through the magnetopause is not only a function of the driving solar wind and interplanetary magnetic field (IMF) conditions, but that the state of the magnetosphere–ionosphere system in part control how much energy enters through the boundary. Furthermore, statistical studies show that even during relatively similar driving conditions, the magnetosphere can assume vastly different dynamic responses, ranging from substorms to steady convection periods, sawtooth events, and magnetic storms. This talk will review the various dynamic responses to the solar wind and IMF and the present understanding of what factors contribute to the large-scale dynamic response. Special attention is paid to the role of the magnetotail and especially the strong and thin current sheet at the tail center, and to the coupling of the solar wind driver and the magnetosphere–ionosphere system.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Spatially–Temporal Regularities of Influence of Sun–Earth Factors on Healthy People

Ragulskaya M.[1], **Vishnevsky V.**[2], **Samsonov S.**[3]

[1]St. Petersburg Branch of IZMIRAN, RU-191023 St. Petersburg, Russia

[2]Institute of Mathematical Machines and Systems, Ukrainian National Academy of Sciences, UA-03187 Kiev, Ukraine

[3]Institute of Cosmophysical Research and Aeronomy, Siberian Branch of the Russian Academy of Sciences, RU-677980 Yakutsk, Russia

The results of 7-years (1998–2005) bio-geo-physical experiment for revealing of spatially-temporal influence of cosmic weather on people are presented. We work with the constant groups of volunteers in different cities, latitude-spaced up to 20°lat. Full number of measurements is > 500000, and > 350 magnetic storms happened during experiment time. The existence of below-listed effects of cosmophysical factors influence on human organism was revealed [M. Ragulskaya, 2004]:

LATITUDE EFFECT – simultaneous measurements at the different latitudes show coincidence of variations of tested parameters. Both percentage number of people and amplitude of their reaction on sharp variations of cosmophysical factors growth under increasing of geographic latitude. TRIGGER EFFECT – Reaction of human organism on influence of external fields has trigger character. At that, the amplitude of reaction not depends on increase of amplitude of external field, but is determined by internal characteristics of the organism. TEMPORAL EFFECT – analysis of long-time data shows the tendency of increase of monthly mean of individual physiological norm of people during the maximum of solar activity and falls during the dropping phase of solar activity. CUMULATIVE EFFECT – Influence of external factors is intensified if they are acting simultaneously and they became bioeffective, even if the amplitude of each separated factor was insufficient for starting of stress-reaction of an organism. AMPLITUDE EFFECT – There is a amplitude corridor of biological efficiency of magnetic storm intensity. Existence of such phenomenon is evidence of realization of parametrical features of the biosystem under influence of natural external fields.

In during 2006 year the extended experiment technique consisted the telecommunication monitoring of on-line portal server registration of electrocardiograms, blood pressure and acupunctural points electroconductivity under relaxation and external load conditions is developing in Moscow, Kiev, Yakutsk, St. Petersburg simultaneously.

✓ OTHER RELATED TOPICS: POSTER

Long-Term Periodicity of Solar Activity and their Response in the Earth's Environment

Raspopov O.M.[1], **Dergachev V.A.**[2]

[1]St. Petersburg Branch of IZMIRAN, PO Box 188, RU-191023 St. Petersburg, Russia

[2]Ioffe Physico-Technical Institute, RAS, RU-194021 St. Petersburg, Russia

Development of long-term solar activity periodicities for the last 8000 years has been studied by analyzing variations in the radiocarbon concentration in annual tree-rings. It has been shown that one of the most intense solar cycle is the ~200 year cycle (de Vries cycle).

Responses of climatic parameters in the last millennium to forcing of the de Vries cyclisity have been analyzed by using the proxy data collected in tree regions of the Earth, *i.e.*, The Tien Shan and Tibet in Central Asia, and Canadian Rockies in western Canada. The data were processed by using spectral and wavelet analysis and filtered in the frequency range related to major solar activity periodicities. The results obtained for various palaeoclimatic reconstruction indicate oscillations in the range of periods of the de Vries ($\sim$210 yr) solar cycles over the past millennium. The quasi-200-year variations revealed in the palaeoclimatic reconstructions correlate well (up to $R = 0.94$) with solar activity variations (Ä14C variations). The quasi-200-year responses were also detected in climatic processes in Asia, Europe, North and South America, Australia, and Arctic and Antarctic. The obtained results point to a pronounced influence of solar activity on global climate change.

Analysis of result of simulation has shown that climate response to the long-term global solar forcing has a regional character. An appreciable delay in the climate response to the solar signal can occur. In addition, the sign of the climate response can differ from the solar signal sign. The climate response to long-term solar activity variations manifests itself in different climatic parameters, such as temperature, precipitations, atmospheric and oceanic circulation, etc. The climate response to the de Vries cyclicity of solar activity has been found to occur not only during the last millennia but also in earlier epochs, to hundreds of millions yeas ago.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Modeling the Storm-Time Inner Magnetosphere: Results from Coupling Ring Current & Radiation Belt Models using Data Assimilation

Reeves G.D., **Friedel R.H.W.**, **Thomsen M.F.**, **Henderson M.G.**, **Jordanova V.K.**

Space Science & Applications Group, Los Alamos National Laboratory, Los Alamos, NM 87545, USA

The International Living With A Star program puts heavy emphasis on the development of systems-level coupled models of the Sun–Earth system in order to develop the scientific understanding needed for a predictive space weather capability. Large-scale models of the magnetospheric response to solar wind input and even models "from sun to mud" have shown remarkable progress in recent years. Large scale MHD (or even hybrid) codes will not, however, provide accurate descriptions of the dynamics of the inner magnetosphere where many of the practical impacts of space weather effects are observed. In this paper we present results from a modeling program designed to specify and predict the energetic particle environment in the inner magnetosphere given appropriate inputs from large-scale models and observations. The Dynamic Radiation Environment Assimilation Model (DREAM) solves the coupled ring current/radiation belt system with the primary objective of understanding relativistic electron acceleration, transport, and losses.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Sharp Solar Wind Ion Flux Changes and the Place Occupied by them in the Large Scale Solar Wind Structures

Riazantseva M.O.[1,2], **Zastenker G.N.**[1], **Khabarova O.V.**[1,3], **Richardson J.D.**[4]

[1]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

[2]Skobeltsyn Institute of Nuclear Physics, Moscow State University, RU-119992 Moscow, Russia

[3]Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, Russian Academy of Sciences, RU-142190 Troitsk, Russia

[4]Center for Space Research, MIT, Cambridge, MA 02139, USA

This work is concerned to sharp (less then 10 min) solar wind ion flux changes, which serve the manifestation of sharp boundaries of small and middle scale solar wind plasma structures. A typical feature of such events is that the solar wind ion flux change is accompanied by very little change in the bulk solar wind velocity, hence, in this case the flux changes are driven by plasma density variations. The problem of the place that the sharp ion flux sharp changes fill in the large scale solar wind structures (as CME, magnetic cloud, heliospheric plasma sheet etc.) and to the area of the influence of such structures is examined. The part of solar wind ion flux sharp changes concerned to quiescent solar wind was estimated. Typical conditions in the solar wind leading to the appearance of sharp and large solar wind ion flux changes are investigated.

✓ OTHER RELATED TOPICS: POSTER

Solar Cycle Variations of Solar Wind Dynamics and Structures

Richardson J.D., **Kasper J.C.**

Kavli Institute for Astrophysics and Space Research, MIT, Cambridge, MA 02139, USA

Over the course of a solar cycle almost every aspect of the solar wind changes. We will describe the variations in the solar wind speed, pressure, helium abundance, and magnetic field and discuss the effects these changes have on the heliosphere. We will also discuss

larger scale structures; ICMEs, which are most abundant near solar maximum but have different configurations in different parts of the solar cycle, corotating interaction regions, which are most prevalent in the descending phase of the solar cycle, and meridional flows, which are observed near solar minimum. We show the parameters of the shocks formed by these structures and how they change with solar cycle. In addition to discussing the effects at 1 AU, we will also show how these structures evolve through the heliosphere and how they effect the solar system boundaries.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Challenges in Prediction in the Coupled Magnetosphere–Ionosphere–Thermosphere System

Rodger A.S.

British Antarctic Survey, Cambridge CB3 0ET, UK

Many of the physical processes that affect the structure and dynamics of the magnetosphere, ionosphere and thermosphere are now reasonably well understood, yet detailed accurate prediction of the environment is not often possible. There are several reasons for this. The complex interactions and feedback mechanisms, that operate over all spatial and temporal scales both within and between the magnetosphere, ionosphere and thermosphere, make prediction of the emergent behaviour particularly challenging. As an example, there is complex interplay between electric fields, field-aligned currents and ionospheric conductivity that has a major impact on energy deposition. Concerning cross scale coupling, two examples of how the micro-structure feeds back on the macro-structure are reconnection on the dayside magnetopause, and the initiation of substorms at the most equatorward arc. Finally there are still some fundamental science questions, such as what controls the location of energy release in the substorm. The presentation will identify some of the key challenges that need to be addressed for improving prediction of the geospace environment, and provide possible approaches that might be adopted both in observation and modeling.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

On the helicity of CMEs throughout a solar cycle

Romoli M.[1], **Georgieva K.**[2], **Kirov B.**[2]

[1]Dipartimento di Astronomia e Scienza dello Spazio, Università di Firenze, I-50125 Firenze, Italy

[2]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

Coronal mass ejections (CMEs) are the most geoeffective solar wind structures. Especially geoeffective are magnetic clouds (MCs) whose main characteristic is the smoothly rotating magnetic field providing prolonged intervals of B_z negative. The relation between CMEs and MCs is not quite clear. The portion of CMEs which are MCs as observed at the Earth's orbit varies throughout the solar cycle: all CMEs observed in sunspot minimum are MCs, while only about 15% of the CMEs in sunspot maximum are MCs. This is consistent with the solar cycle dependence of the helicity transferred from the solar interior into the corona, so one possibility is that a CME is a MC when there is enough helicity stored in the corona which it carries away. There is, however, another possibility: that all CMEs are MCs, but their inclination, or the observational position at the Earth, change throughout the solar cycle, so not all of them are registered as MCs at the Earth's orbit. This question is very important for understanding the generation of CMEs because some theories of CME initiation require helicity. One way to answer this question is to check whether all CMEs contain helicity close to the Sun. There are two coronagraphs on board of SOHO that observe CMEs between 1.5 and 30 solar radii: LASCO and UVCS. LASCO is a broad band white light coronagraph and the only way to get helicity is to look at the twisting or untwisting of the filament rope in the few cases where it is clearly visible. UVCS measures Doppler shifts, but only at a single height, and the interpretation of the shift is most of the time not straightforward. Here we investigate the possibility of estimating the portion of CMEs that contain helicity and their variation in the last solar cycle from the measurements of LASCO and UVCS.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Delayed Enhancement of Relativistic Electrons in Impulsive Solar Flares and Active Magnetospheres

Roth I.

University of California, Berkeley, CA 94720, USA

Impulsive solar processes result in delayed injections of relativistic electrons along the heliospheric field lines. Terrestrial processes during the recovery phase of magnetic storms result in formation of trapped relativistic electrons on the magnetospheric field lines.

Although both phenomena consist of different magnetic configurations, they include initial external loading, deformation of magnetic field and bootstrap of electron energies. We suggest that both the terrestrial and the solar energization mechanism rely on excitation of whistler waves which propagate along the inhomogeneous magnetic field, due to low energy electrons which are injected by substorm reconnection or coronal shock, respectively. Both environments sustain unstable magnetic configuration, while the delayed energization occurs due to an additional distant reconfiguration, on fast time scales and large spatial scales. In the terrestrial environment effective energization occurs only when an injection of low-energy substorm electrons occurs in the recovery phase of magnetic storm. In the solar environment effective energization occurs when large scale coronal perturbation ensues a flare. The time scales are accordingly few hours and tens of minutes, respectively.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES:

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HF Wave Activity in the Low and Middle Altitude Polar Cusp

Rothkaehl H.[1], **Trotignon J-G.**[2], **Decreau P.**[2], **Becki J.**[1], **Parrot M.**[2], **Pitout F.**[3], **Reme H.**[4]

[1]Space Research Centre, PAS, 18a Bartycka Street, PL-00 716 Warsaw, Poland

[2]LPCE/CNRS, 3A avenue de la Recherche Scientifique, F-45071 Orleans Cedex 2, France

[3]ESA/ESTEC, NL-2200 AG Noordwijk, The Netherlands

[4]CESR/CNRS, F-31028 Toulouse Cedex 4, France

The polar cusp-cleft is a very sensitive region of the Earth environment for the changes of geomagnetic condition and is one of the regions, where the most intense electrostatic as well as electromagnetic waves are generated.

The waves measurements registered by WHISPER and STAFF instrument and plasma particle measurements gathered by CIS instrument located on the Cluster satellites were used to analyses plasma property in mid altitude cusp region at the distance of few Earth radii on August and September 2002. The analysed data indicate a different type of waves activity at HF frequency ban whistler, electron cyclotron, Langmuir, electron acoustic waves.

Similarly high time resolution wave measurements and electron and ions spectral diagnostics located on the board of Freja satellite were used to study the response of ionospheric plasma to the strong geomagnetic storm within low altitude cusp-cleft region. Both the electrostatic and electromagnetic emissions in the VLF frequency as well as high frequency whistler waves and plasma electron waves have been detected. The aim of this paper is to study the plasma property at low and middle altitude cusp-cleft region and to analyse the property of different excited HF mode during varying geomagnetic condition.

✓ CLUSTER OBSERVATIONS AND THEORY: POSTER

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New Solar Views that May Lead to a Better Understanding on the Earth's Environment

Rozelot J.-P.

Observatoire de la Côte d'Azur, Gemini Department, F-06130 Grasse, France

During the last five years, studies of the Sun and Sun–Earth relationships have dramatically changed our view on Solar Terrestrial Physics. We will here focus on new views on the solar interior. The internal non-homogeneous mass distribution and non-uniform angular velocity (function of the radial distance to the center and of the latitude) yield a complex outer shape. Beyond a 'spherical' Sun is a new understanding of solar physics, such as gravitational energy or how unexplained faint irradiance variations might be produced. Such questions must be solved to understand how the solar output may influence our Earth's environment (helioclimatology). We will emphasize the key role of the sub-surfacic layers (the leptocline, recently put in evidence by helioseismology) for a better prediction of the solar cycles.Regarding the solar core dynamics, the subject is of high priority for new investigations: we will conclude by giving some imprints on space-dedicated missions, such as Golf-NG/Dynamics in a joint effort with SDO (Solar Dynamics Observatory).

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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The Sun and the Moon as sources Forming 'Space Weather' and their Common Influence on the Erath's Ionosphere, Atmosphere and Biosphere

Ryabov M.I.

Odessa Observatory of the Radioastronomical Institute, Ukrainian National Academy of Sciences, UA-270011 Odessa, Ukraine

Traditional meaning 'space weather' as effects of display of solar and geomagnetic activity is insufficient. Lunar tidal waves in the upper Earth's atmosphere also are an essential part of 'space weather'. Observational results on a radio telescope 'Uran-4' IRA NANU

are the experimental to confirm this statement. Since 1987 year and till the present time the program of monitoring fluxes of powerful galactic and extra-galactic radio sources on this telescope is carried out. Changes of a radio sources flux at the time of distribution of their radiation through an ionosphere of the Earth are related to variations ultraviolet and x-rays and corpuscular streames in a cycle of solar activity. Observation results on a radio telescope 'Uran-4' were detected 'plasma lensing' of emission of cosmic radio sources at their observation through a lunar tidal waves. Data of these observations show great spacial scales of the tidal waves in Earth's ionosphere. The observational measuring of condactivity of biologically active points at group of exaamined persons and number of Myxobacteria population show presence of the reaction to solar and geomagnetic activities and display of lunar tides.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Causes and Properties of Cyclic Solar Activity

Schrijver C.J.

Lockheed Martin Advanced Technology Center, Palo Alto, CA 94304, USA

Solar activity exhibits a pronounced 11-year cycle even as many stars like the Sun do not. In this tutorial overview, I plan to compare properties of solar and stellar magnetic activity, and to review current concepts of the dynamo processes that drive this activity.

✓ PLENARY LECTURES: ORAL

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Analytical Expressions for Flux-Tube Volume and Hamiltonian for Diffuse-Auroral Electrons in a Field-Line Model of the Ring Current

Schulz M.[1], **Chen M.W.**[2]

[1]Lockheed Martin Advanced Technology Center, Palo Alto, CA 94304, USA

[2]Space Science Applications Laboratory, The Aerospace Corporation, Los Angeles, CA 90009-2957, USA

The equation of a magnetic field line (labeled L) in Dungey's model magnetosphere (dipole field plus uniform southward $\Delta\boldsymbol{B}$) is $r = La[1 + (r^3/2b^3)]\sin^2\theta$, where r denotes geocentric distance, θ denotes magnetic colatitude, a is the Earth's radius, and b is the radius of the field model's equatorial neutral line. This model can be generalized (*e.g.*, to accommodate a ring current) by treating b as a function of L and φ (magnetic local time) rather than as a constant, so as to yield measured or calculated values of the equatorial magnetic field B_0. (In this generalization the equatorial neutral line has a radius $b^*(\varphi) = (3a/2)L^*(\varphi)$ for some particular φ-dependent value of L called L^*.) This approach yields an estimate for how a specified distortion of equatorial B_0 might map to higher latitudes. It also allows for analytical calculation of the current density $\boldsymbol{J} = (c/4\pi)\boldsymbol{\nabla}\times\boldsymbol{B}$ at arbitrary latitude. Since charged particles (of scalar momentum p) scattered strongly in pitch angle satisfy an adiabatic invariant $\Lambda = \pi^{\Psi}$, where Ψ is the flux-tube volume (per unit magnetic flux), it is of interest to approximate (as well as possible) the flux-tube volume Ψ as a function of L and φ. By generalizing the calculation of Schulz [*JGR*, 103, 61–67, 1998], we have found such an analytical approximation of Ψ for arbitrarily non-constant b and are proceeding to use it in bounce-averaged transport simulations of diffuse auroral electrons described by a Hamiltonian function $H(L,\varphi;t) = [(\Lambda/\Psi)^{2/3} + (m_0c^2)^2]^{1/2} - m_0c^2 + qV(L,\varphi;t)$, where q is the electronic charge and $V(L,\varphi;t)$ is the electric scalar potential function.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

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On The Sources of Suprathermal Particles

Schwadron N.A., **Desai M.**, **Hill M.**, **Posner A.**

Boston University, Southwest Research Institute, Advanced Physics Laboratory, Boston, MA 02215, USA

Understanding the properties of solar energetic particle (SEP) events associated with coronal mass ejections or CMEs remains an outstanding problem for the solar-heliospheric community. However, contemporary CME/SEP models are unable to predict key properties (*e.g.*, peak proton intensities) of these events. Consequently, the aim of developing a global Space Weather Monitoring System that can accurately predict radiation levels during such events remains highly elusive. Recent observations from the ACE spacecraft (*e.g.*, $^3He^{2+}$ and $^4He^{+}$ ions) have provided compelling evidence that CME-driven shocks draw their source material from a highly variable, ubiquitous but largely unexplored suprathermal tail rather than from the more abundant solar wind peak [Desai *et al.*, 2001; Kucharek *et al.*, 2003]. Thus, presently not only is the suprathermal energy regime poorly understood, but also more crucially the effects of its variations on CME-related SEP properties are also completely unknown. Indeed, the injection of a suprathermal seed population that varies in time and with distance into the acceleration process is a critical first step for CME/SEP models that aim to predict key properties of these dangerous events and provide advance warning to astronauts and hardware in space. We describe composition

measurements from Cassini en route to Saturn to characterize the temporal and spatial evolution of the suprathermal ion population in the 3D-heliosphere inside $\sim$10 AU. We also describe a theoretical framework for understanding the main causes of the variability of the different ion sources and model the dynamical properties of the suprathermal ion population in the inner heliosphere. We further describe implications of the investigation for understanding the effects of and inherent variability of the suprathermal tail on the ion populations accelerated at CME-driven shocks in the heliosphere.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

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Experiments for Radiation Detection and Dosimetry for Estimation of the Space Weather Radiation Impact to Crewmembers on Long Duration Space Missions

Semkova J.[1], **Koleva R.**[1], **Todorova G.**[1], **Kanchev N.**[1], **Maltchev St.**[1], **Petrov V.**[2], **Shurshakov V.**[2], **Benghin V.V.**[2]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]State Scientific Center of Russian Federation, Institute of Biomedical Problems, Russian Academy of Sciences, RU-123007 Moscow, Russia

Space weather radiation effects to crew health, performance and life expectancy is a major obstacle to human space exploration. Sources of ionising radiation onboard manned spacecraft are the galactic cosmic rays, solar energetic particles events, emitted during solar flares, trapped radiation, as well as secondary radiation. At some periods solar cosmic rays are the most essential component of space radiation.

Predicting the effects of radiation on humans during long-term space missions requires accurate knowledge and modeling of the space radiation environment, calculation of primary and secondary particle transport through shielding materials and through the human body, and assessment of the biological effect of cosmic particles, especially heavy charged particles (HZE).

The current models for radiation risk assessment lead to evaluations with very large uncertainties because of the lack of knowledge of i) the source term (precise radiation composition, energy spectrum, flux, ii) the different interactions of cosmic radiations in matter needed for the calculation of shielding or the dose in the human body and, iii) the biological effects of cosmic particles, especially HZE particles.

The International Space Station (ISS) internal radiation environment is complex, with incident external space radiation field modulated by widely varying amounts of shielding and internal material, including the astronaut's bodies. For the estimation of the organ doses, and thus the radiation risk, measurements in human phantoms are essential.

Described are the method and experiment Liulin-5 developed for investigation of the radiation environment dynamics within the Russian human phantom on ISS. Liulin-5 experiment will be a part of the international project MATROSHKA-R on ISS. Liulin-5 is planned to be flown on the ISS in 2006 year. Data obtained together with data from other radiation measurements on ISS will allow to estimate the radiation risk to the crewmembers, verify the models of radiation environment as well as calculation models for particles transport and dose assessment.

Concerning the human exploration of Mars, the radiation exposures to be received in transit to Mars and on the Mars surface have to be assessed.

Adaptations of the techniques developed for investigation of the radiation environment on ISS would be used for investigation of the radiation hazards during future exploratory missions as well as a part of the radiation safety system for manned deep space missions.

✓ OTHER RELATED TOPICS: POSTER

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Analysis of Plasma and Magnetic Field Turbulence in Solar Wind, Foreshock and Magnetosheath by Data of Several Spacecraft

Shevyrev N.N.[1], **Zastenker G.N.**[1], **Du J.**[2], **Wang C.**[2]

[1]Space Research Institute, Russian Academy of Sciences, 84/32 Profsoyuznaya Street, RU-117997 Moscow, Russia

[2]Center for Space Science and Applied Research, Chinese Academy of Sciences, Beijing 100080, China

INTERBALL-1 ion flux and magnetic field fluctuations on various timescales (from less than 1 s to 1 hour) in solar wind, foreshock and magnetosheath during 1996–2000 were analyzed and compared with results of similar data analysis from CLUSTER and TC-1 (Double Star) spacecraft. The properties of plasma and magnetic field turbulence are strongly different in undisturbed solar wind, foreshock and magnetosheath. Fluctuations of parameters in the magnetosheath and foreshock are much more intensive than in undisturbed solar wind and they are mostly nonlinear with amplitudes more than 10%. Properties of the small-scale turbulence in the magnetosheath are strongly controlled by orientation of interplanetary magnetic field with respect to bow shock (Theta(Bn) angle). The influence of other solar wind macro parameters on the characteristics of the turbulence in foreshock and magnetosheath were also investigated.

✓ CLUSTER OBSERVATIONS AND THEORY: POSTER

Plasma Ejections and Shock Waves in the Solar Atmosphere

Magara T., **Shibata K.**

Kwasan and Hida Observatories, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan

Recent space solar observations have revealed that the solar atmosphere is much more dynamic than had been thought and is full of plasma ejections and shock waves. It is interesting to note that as observational accuracy become better and better, more and more tiny jets, shocks, and small flares (microflares and nanoflares) have been found. It is also interesting to note that the structure and dynamics of these tiny phenomena are often similar to those of larger phenomena. This led us to develop unified model of these dynamic phenomena in the solar atmosphere, in which magnetic reconnection and plasmoid ejections play an important role. Here, we will discuss recent observations of plasma ejections and shock waves from solar flares and flare-like phenomena, including coronal mass ejections (CMEs), and discuss how these phenomena are interpreted in a unified model. We also discuss recent progress of magnetohydrodynamic (MHD) simulations of these dynamic phenomena, including jets, plasmoid ejections, and coronal mass ejections, which are all related to magnetic reconnection. Finally, we briefly report on recent development of Japanese solar observations, such as Solar B mission of JAXA/ISAS with US/UK/EXA collaboration, and SMART (solar magnetic activity research telescope) at Hida observatory, which enables continuous full Sun observations of vector magnetic field and H alpha images. The latter telescope will contribute to space weather study and will be one of important parts of international collaboration project CHAIN (Continuous H Alpha Imaging Network) led by CAWSES (Climate And Weather of the Sun and Earth System).

✓ CLUSTER OBSERVATIONS AND THEORY: POSTER

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Precipitation of Energetic Electrons from Outer Radiation Belts into the Earth's Ionosphere as the Main Source of Loss of These Particles after Geomagnetic Storms

Shirochkov A.V., **Makarova L.N**

Arctic and Antarctic Research Institute, RU-199397 St. Petersburg, Russia

The inner magnetosphere charged particle population consists mainly of energetic electrons with energies up to $\sim$ 10 MeV. Their number increased significantly during geomagnetic storms and superstorms with subsequent decaying during several days after storm beginning. Competition between rise and fall of energetic electron population in the outer belts attracts close attention of many space scientists. The physical processes responsible for the temporal variations of energetic electron population in radiation belts are still poorly known. One of a probable source of their loss is thought to be precipitation into the Earth's ionosphere and atmosphere. The satellite measurements provide most of such information but only few of them contain data of the particles pitch-angle distribution *i.e.* about actual intensity of precipitating fluxes.

In this report the ground-based ionospheric observations (riometers and VLF phase measurements) are considered as reliable and low-cost methods of monitoring process of energetic electron precipitation during geomagnetic disturbances. Data of these measurements clearly demonstrate a significant increase of ionospheric absorption and VLF phase negative deviations during geomagnetic storms and superstorms, which definitely are attributed to real penetration of energetic particles into ionosphere and atmosphere. We explore in details such important aspects of this process as positions of both polar and equatorial boundaries of the particle precipitation zones, peculiarities of the temporal/spatial distribution of these zones etc. Our conclusion is that precipitation of these particles into the Earth's ionosphere and atmosphere is the main process of loss of energetic electron population in the radiation belts during geomagnetic storms. Other possible ways of these particles loss are considered also.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

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Orbital Variations, Solar Irradiance or Cosmic Rays Drive the Earth's Climate?

Shopov Y.Y.[1], **Stoykova D.A.**[1], **Ford D.C.**[2], **Yonge C.J.**[3]

[1]University Center for Space Research and Technologies, University of Sofia, 5 James Bourchier Blvd., BG-1164 Sofia, Bulgaria

[2]Geography Department, McMaster University, Hamilton, Ontario L8S 1K4, Canada

[3]Department of Physics, University of Calgary, Calgary, Alberta T2N 1N4, Canada

We studied Cosmic Rays, Solar Luminosity and Orbital Variations as potential driving forces of the Earth's Climate. A link between cosmic rays intensity and cloud cover has been discovered recently. It suggests that cosmic rays serve as nucleation centers for condensation of the water in the clouds. This suggests a strong positive correlation between the solar activity (especially solar luminosity variations) and the global temperature. Solar luminosity variations correlate with the solar wind strength. Stronger solar wind produces lower cosmic rays flux and lower cloud cover. The lower cloud cover produces higher sky transparency and higher solar insolation at the Earth's surface and the reverse. So cosmic rays-cloud cover mechanism multiply the solar luminosity variations in the solar radiation (insolation) at the Earth's surface.

Theoretical curves of the orbital variations of the solar insolation (SI) explain only 1/2 of the real variations of the SI due to a number of incorrect presumptions made by the Milankovitch theory. They contain also variations of the solar luminosity and Earth parameters. For quantitative correlation is necessary to use experimental records of the solar insolation. Speleothem luminescence is still the only proxy producing such records. Luminescence solar index we used represents solar insolation variations on the Earth's surface, so is the most appropriate solar proxy for study of the connection between Earth's climate and solar activity. We found a cycle of 11 500 years producing variations of $\pm 3.6\%$ of the solar radiation (insolation) in our experimental records. Involving the cosmic rays mechanism it can be produced by much smaller variations of the solar luminosity. This most powerful solar cycle is as intensive as most Milankovitch cycles and can produce climatic variations with intensity comparable to that of the orbital variations. Known decadal and even century solar cycles have negligible intensity (100 times less intensive) relatively to this cycle. We estimated how big variations of the effective temperature of the Sun can produce these variations.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Structure and Interactions of the Solar Dust Corona with the Other Coronal Components

Shopov Y.Y.[1], **Stoykova D.A.**[1], **Stoitchkova K.**[1], **Tsankov L.T.**[1], **Belchev St.**[2], **Rusanov V.**[1], **Ivanov D.**[1], **Stoev A.**[3], **Stoev St.**[3], **Muglova P.**[4], **Iliev I.**[4]

[1]Faculty of Physics, University of Sofia, 5 James Bourchier Blvd., BG-1164 Sofia, Bulgaria

[2]Faculty of Chemistry, University of Sofia, 1 James Bourchier Blvd., BG-1164 Sofia, Bulgaria

[3]Yury Gagarin Public Astronomical Observatory, BG-6000 Stara Zagora, Bulgaria

[4]Institute of Astronomy, Bulgarian Academy of Sciences, BG-1784 Sofia, Bulgaria

We made registration of the dust solar corona up to 20 solar radius far from the Sun on 16 Infrared films. Observations were made during the total solar eclipses on 11 August 1999 and 29 March 2006 in 15 different regions of the near IR and visible light. Obtained images reveal different shapes and structure of the solar corona in different spectral regions. This phenomena is attributed to different absorption and reflection by different components of the interplanetary dust in different spectral regions. We use obtained images to study the structure of the dust corona and its interactions with the other components of the solar corona and solar wind. This way we demonstrate that coronal streamers penetrate deeply dust solar corona producing uneven internal boundary of the dust corona by evaporation or sublimation of the dust material. They may cause also chemical decomposition of the compounds of the dust particles and other types of emission in the far solar corona.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Parametrizations of the Electron Lifetimes

Shprits Y.Y., **Thorne R.M.**

UCLA, Los Angeles, CA 90095-1567, USA

The variability of the radiation belt relativistic electrons is due to a competition between various loss and source processes. Resonant wave-particle interactions may scatter electrons into the loss cone which results in the loss of particles form the system. The scattering rates due to whistler chorus and EMIC waves are computed using quasi-liner approximations. Thus computed diffusion rates are used in the pitch angle scattering code to determine the decay rates of the phase space density due to interactions with various plasma waves. We show that electron lifetimes are primarily determined by the scattering rates near the edge of the loss cone. In particular high latitude chorus waves and EMIC waves may provide dominant scattering of the particles into loss cone. We also present parameterizations of lifetime due to various plasma waves which can be used in particle tracing codes and ring current codes.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Radial Diffusion as a Loss and Source Process of the Relativistic Electrons

Shprits Y.Y.[1], **Thorne R.M.**[1], **Reeves G.D.**[2], **Friedel R.H.W.**[2], **Fennell J.**[3], **Baker D.N.**[4]

[1]Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, CA 90095-1565, USA

[2]Los Alamos National Laboratory, Los Alamos, NM 87545, USA

[3]The Aerospace Corporations, PO Box 92957, Los Angeles, CA 90009-2957, USA

[4]Laboratory for Atmospheric and Space Physics, Boulder, CO 80309, USA

The variability of the radiation belt electron fluxes is a result of a competition between various source and loss processes, which highly depend on the evolution of the plasmaspheric and ring current plasma populations.

Relativistic electrons can be accelerated by the inward radial diffusion, which is most efficient at higher L-shells and by local acceleration which is most efficient right outside plasmasphere. Losses of relativistic electrons may result from pitch angle scattering of electrons by various plasma waves and losses to magnetopause. Using observations from CRRES, HEO, and SAMPEX satellites and radial diffusion modeling we show that magnetopause losses combined with outward radial diffusion may produce significant depletions of the outer radiation belt down to $L = 4$. We also show that radial diffusion driven by gradients in phase space density redistributes radiation belt fluxes and may effectively work as a loss and source process.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

THEMIS: Substorms, Radiation Belts, and Dayside Interactions

Sibeck D.G.

NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

THEMIS, NASA's most recent Explorer mission, comprises 5 identically-instrumented spacecraft that will be launched in the Fall of 2006. The primary science objective of the mission is to determine the cause of substorm onset. To achieve this objective, the 5 spacecraft will be sent into orbits that bound the expected positions of the current disruption region and reconnection line in the Earth's magnetotail. Timing analysis will reveal where and when substorms begin. A dedicated array of ground observatories will place the magnetotail observations within their global context. While on the dayside, the spacecraft will be used to define the processes that govern the solar wind-magnetosphere interaction and occur within the foreshock, magnetosheath, and at the magnetopause. Throughout the mission, the spacecraft will be used to determine the properties of the Earth's radiation belts. THEMIS actively encourages correlative studies: all THEMIS data sets will be publically available.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Bubble Phenomenon in the Topside Ionosphere: High Solar Activity Period

Sidorova L.N.

Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, RU-142190 Troitsk, Russia

There are the indications that plasma bubbles, produced by Rayleigh–Taylor instability at the bottomside of ionosphere, could rise up to the topside ionosphere and plasmasphere. Maryama and Matuura (1984), using ISS-b satellite data (high solar activity period, 1978–79), have seen the plasma bubbles in Ne density over equator at 1100 km altitudes in 46 cases in 1700 passes. That is $\sim 3\%$ only. However, there is distinctly another picture in He+ density depletions (subtroughs) according to ISS-b data for the same period. He+ density subtroughs occur in the topside ionosphere over equatorial and low-latitudinal regions ($L \sim 1.3$–3) in 11% of the cases (Karpachev, Sidorova, 2002; Sidorova, 2004). The detailed statistical study of the He^+ density subtrough peculiarities was done. The subtrough depth (depletion value) as function of local time (evening-night hours) was compared with the vertical plasma drift velocity variations, obtained for the same periods from AE-E satellite and IS radar (Jicamarca) data. Striking similarity in development dynamics was revealed for the different seasons. It was noted also that the He+ density subtroughs are mostly observed in the evening-night sector (18-05 LT) from October till May. It was like to the peculiarities of the equatorial spread-F (ESF), usually associated with plasma bubble. The monthly mean He^+ density subtrough occurrence probability, plotted in local time versus month, was compared with the similar plots for ESF occurrence probability, derived by Abdu and colleagues (Abdu *et al.*, 2000) from ground-based ionograms obtained over Brazilian region for the same years. The comparison shows good enough correlation ($R = 0.67$). It was concluded that: (a) He^+ density subtroughs like ESF are controlled by prereversal enhancement electric field (vertical drift (b) He^+ density subtroughs and ESFs may be considered as phenomena of the same plasma bubble origin (c) it seems, plasma bubbles, reaching the topside ionosphere altitudes, are most easily observable in He^+ density as depletions.

References

[1] Maryama, T. and N. Matuura, "Longitudinal Variability of Annual Changes in Activity of Equatorial Spread F and Plasma Bubbles", *Journal of Geophysical Research* **89** (A12), 10.903-10.912, December 1, 1984.

[2] Karpachev, A.T. and L.N. Sidorova, "Occurrence probability of the light ion trough and subtrough in He^+ density on season and local time", *Adv. Space Res.* **29**, 999–1008, 2002.

[3] Sidorova, L.N., "He^+ density topside modeling based on ISS-b satellite data", *Adv. Space Res.* **33**, 850–854, 2004.

[4] Abdu, M.A., J.H.A. Sobral, I.S. Batista, "Equatorial spread F statistics in the american longitudes: some problems relevant to ESF description in the IRI scheme", *Adv. Space Res.* **25**, 113–124, 2000.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Pc1-2 Pulsations and Narrow-Band Wave Events Observed in the Plasma Mantle

Singh S.V.[1], **Teodosiev D.**[2], **Nenovski P.**[3], **Lakhina G.S.**[1], **Koleva R.**[4], **Vojta J.**[5]

[1]Indian Institute of Geomagnetism, New Panvel, Navi Mumbai 410218, India

[2]Space Research Institute, Bulgarian Academy of Sciences, BG-1000, Sofia, Bulgaria

[3]Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[4]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[5]Institute of Atmospheric Physics, Bocni II., CZ-141 31 Prague, Czech Republic

ULF wave activities in the plasma mantle are studied using Pc1-2 electromagnetic observations by the Magion-4 satellite of the Interball-1 spacecraft. These waves are characterized by intense narrow band waves (of frequency ∼0.33 Hz) observed near the magnetopause and broadband waves having discrete bursts of ∼ minute duration. The frequency of these narrow band waves seems to be stable while their intensity is modulated. The narrow band waves have 3 seconds period and are similar to waves observed in the for shock region by ISEE satellite. Observation of narrow-band events in the magnetopause region at a frequency below the ion cyclotron frequency suggests that they may be associated with anisotropic ion fluxes flowing just inside the plasma mantle. A mechanism for the generation of such waves based on anisotropic particle distribution is proposed.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: POSTER

Geomagnetic Pulsations in Terms of Standing Alfvén Waves and Their Response to Solar Wind Pressure Variation

Sinha A.K.[1], **Nenovski P.**[2], **Bochev A.**[3], **Rajaram R.**[1]

[1]Indian Institute of Geomagnetism, New Panvel, Navi Mumbai 410218, India

[2]Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[3]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

Change in solar wind dynamic pressure results in the oscillations of surface current at the magnetopause boundary in order to nullify the pressure imbalance. These current oscillations cause compressional variation in the magnetic field. Coupling of these compressional waves can cause selected field lines to oscillate resulting into geomagnetic pulsations observed in space or ground. In this paper we examine the role of solar wind pressure variation in generating the observed geomagnetic pulsations. The paper takes accounts of both theoretical and observational perspectives.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Longitudinal Distribution of Coronal Mass Ejections

Skirgiello M.

Space Research Center, Polish Academy of Sciences, PL-00 716 Warsaw, Poland

Solar activity is unevenly distributed over heliolongitudes. Existence of especially active longitudinal zones for sunspots, active regions, flares, photospheric magnetic field, coronal green-line brightness, and many other solar activity manifestations has been reported for a long time. Here, coronagraphic data from Skylab (1973/74), Solwind (1979–1985), SMM (1980, 1984–89), and SOHO (1996–2005) are used to study the longitudinal dependence of CMEs. In this data set, several periods of one active longitude, lasting up to about 2.5 years, as well as a few shorter time-periods of two opposite active longitudes, were found. This pattern is similar to that of coronal green-line intensity demonstrated by Sykora and Rybak (2005). Moreover, periods of clear longitudinal dependence in CME data enable to draw some conclusions on visibility function for CMEs.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

Coronal Mass Ejections: on the Way to Quantitative Simulations

Sokolov I.V.[1], **Roussev I.**[2]

[1]University of Michigan, Ann Arbor, MI 48109, USA

[2]University of Hawaii, Honolulu, HI 96822, USA

Coronal Mass Ejections (CMEs) at the Sun are accompanied by an abrupt energy release, dramatic changes in the magnetic topology, fast plasma flows and the shock waves generation as well as the solar energetic particles acceleration. To quantify the physical processes

involved, one needs to provide the numerical models which include the realistic three-dimensional structure of the solar wind, a seeding level of turbulence and its change across the shock wave, the structure and the parameters of the magnetic clouds errupted in the course of the CME. The particle acceleration and transposrt through the turbulent magnetized plasma is also an essential aspect of the CME simultions. In the present paper we describe the models and the frameworks which promise to become the building blocks in the future global model for describing and predicting the CMEs influence on the geomagnetic activity as well as on the radiation environments on board the spacecraft.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

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The Solar Total and Spectral Irradiance Since the Maunder Minimum

Solanki S.K.[1], **Krivova N.A.**[1], **Balmaceda L.**[1], **Wenzler T.**[1,2]

[1]Max Planck Institute for Solar System Research, D-37191 Katlenburg-Lindau, Germany

[2]Institute of Astronomy, ETH Zürich, CH-8092 Zürich, Switzlerland

Precise solar total irradiance measurements started in 1978, spectral irradiance even later. Total and spectral irradiance changes may influence the Earth’s climate. Total irradiance describes the external energy input to Earth, while spectral irradiance influences the chemistry in the stratosphere and higher atmospheric layers. For a comparison with the Earth’s climate it is necessary to have irradiance time series that are longer than the measured records. In particular, an estimate of the amount of irradiance variations since the Maunder minimum is needed. We present a reconstruction of solar total and spectral irradiance since the Maunder minimum based on a model of the evolution of the Sun’s total and open magnetic flux. The reconstructed UV irradiance spans the wavelength range from Ly alpha to the far infrared (115 nm to 160 microns). This reconstruction reproduces the major available data sets (total irradiance composite; UV spectral irradiance time series, time series of measured total magnetic flux and the open magnetic flux reconstructed from the geomagnetic aa index). We find that the Sun’s cycle-averaged total irradiance has increased by roughly 0.1% since the Maunder minimum. The majority of this increase occurs at UV wavelengths.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

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Geoeffective Solar Wind Structures Investigation by MHD Approximation and through the Similarity and Dimensional Method

Srebrov B.A.

Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

Large geomagnetic storms are usually caused by structures in the solar wind having specific features. These features are effective in causing geomagnetic disturbances and are called geoeffective. We use the Magneto-Hydrodynamic (MHD) model and a computer simulation for investigation of the geoeffective structures which are highly correlated with the Coronal Mass Ejections (CMEs). It is an eruptive solar phenomenon in which an enormous amount of plasma ($\sim 10^{10}$ kg) and magnetic energy ($\sim 10^{28}$ erg) are ejected by the Sun at high speed ($\sim$1500 km/s). These geoeffective solar wind structures are interplanetary plasma parameters disturbances and changes of the Interplanetary Magnetic Field (IMF). Investigations of Explosion phenomena with Release in the ambient medium of Mass and Energy based on the Similarity and Dimensional Method (SDM) have been made. These both (MHD and SDM) methods of explosion phenomena investigation have different approach but the results, which we have obtained in these two cases show some similarities. This allows drawing the conclusion that MHD modeling of the structures in the Interplanetary Space is a refinement of the modeling of explosions in a contractible medium. The specific features of the MHD motion of a fluid with high electric conductivity are included in addition. The discussed two methods are not equivalent and different understanding of the disturbed interplanetary structure is obtained using them. We can get in both cases similar or identical structures of the interplanetary disturbances. In the spirit of the theory of similarity and dimension we have carried out investigations of similar disturbances in laboratory conditions as these caused by CMEs associated with solar chromosphere flares. In this case is not necessary to follow strictly the similarity circumstances and as a result we observe quite relative motion laws of the laboratory and interplanetary disturbances.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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HeII 468.5 nm Observation in the Chromosphere during the March 29, 2006 Total Solar Eclipse

Stoeva P.[1], **Kuzin S.**[2], **Pertsov A.**[2], **Stoev A.**[3], **Stoyanov N.**[3]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Lebedev Physical Institute, RU-117924 Moscow, Russia

[3]Yury Gagarin Public Astronomical Observatory, BG-6000 Stara Zagora, Bulgaria

Spectroscopic study of the HeII 468.5 nm line in the low chromosphere of the Sun has been made. Observations were conducted during the total solar eclipse on March 29, 2006 at Manavgat, Turkey. Spectrograph was designed by specialists from STIL-BAS ‘Acad.

D. Mishev', Stara Zagora Department, Bulgaria, Lebedev Physical Institute, Moscow, Russia and Yuri Gagarin Public Astronomical Observatory, Stara Zagora, Bulgaria.

Results from observations are presented and compared with those of other authors.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Basic Microclimaic Parameters and Their Dynamics during the Total Solar Eclipse on March 29, 2006

Stoev A.[1], **Stoeva P.**[2], **Kiskinova N.**[1], **Stoyanov N.**[1]

[1]Yury Gagarin Public Astronomical Observatory, BG-6000 Stara Zagora, Bulgaria

[2]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

Dynamical changes in the physical state of the 10 m ground atmospheric layer owing to a sharp drop in the direct solar radiation have been investigated during the March 29, 2006 total solar eclipse (TSE). Observations were conducted near the town of Manavgat, Turkey. Temperature, humidity, barometric pressure, speed and direction of the wind were measured with a specially designed quick automatic meteorological station with high resolution, at intervals of 1 m. In addition, temperature and evaporation in the 20 cm soil layer were measured.

The difference in temperature changes at different heights before, during and after the total phase is in the interval 2 aC–4 aC. Minimum of the air temperature during the TSE was measured 1min after the end of the total phase. Barometric pressure was sharply changed from 1021 hPa – at the beginning of the eclipse (09h 37min 33sec) to 1028 hPa – 1 min 26 sec after the end of the total phase (10h 57min 34sec). The relative humidity increases from 72% up to $\sim$76% after the total phase. Speed of the wind was measured in 5 minutes during the partial phases and in 1 min during the total phase. It decreases with 3 m/s just before the total phase and increases after the end of the total phase changing its direction from south-east to north-east, which coincides with the motion of the lunar shade on the earth.

Our measurements of the microclimatic parameters have been compared with those of meteorological observatories located in the region of totality near Manavgat – the towns of Antalya and Konya.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Investigation of the White Light and Monochromatic Corona Structure during the Total Solar Eclipse on March 29, 2006

Stoeva P.[1], **Stoev A.**[2], **Kiskinova N.**[2], **Velkov R.**[2]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Yury Gagarin Public Astronomical Observatory, BG-6000 Stara Zagora, Bulgaria

Results from photographic observations of the white and monochromatic solar corona conducted during the total phase of the total solar eclipse on March 29, 2006 in Manavgat, Turkey are shown in this work. Structure of the solar corona and boundaries of the inner, middle and outer corona have been investigated using 49 photos. Total brightness of the corona, as well as its surface brightness at different distances from the centre of the solar disk has been determined.

Difference between polar and equatorial diameter of the corona and its electron concentration and temperature have been calculated.

Results are compared with those obtained from the total solar eclipse on August 11, 1999.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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Geophysical Variables and Human Health and Behavior

Stoilova I., **Dimitrova S.**

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

The effect of geophysical factors on human health and behavior is not an artifact or an occasional event. In the last years the increasing number of investigations and scientific papers confirm the existence of this effect.

The basic factors that could affect human health and behavior are: changes of the solar activity, geomagnetic field variations, meteorological changes as well as the changes in geochemical and tectonic processes. There are facts that all of them could influence mutually

each other. This is the reason that it is usually very difficult to separate the different influences as well as very easily to omit the effects oh human beings.

The subject of this paper are the probable biological mechanisms according to which geomagnetic field variations could influence on the physiological and behavioral reactions of people as well as presentation of some of our results obtained confirming this effect.

Investigations in that field in spite of the objective difficulties and the results obtained through cooperation of different specialists and at different latitudes will be extremely useful for developing measures and strategies for protecting man from the harmful effects of geophysical factors.

✓ OTHER RELATED TOPICS: POSTER

Origin of the Climatic Cycles from Orbital to Sub-Annual

Stoykova D.A.[1], **Shopov Y.Y.**[1], **Tsankov L.T.**[1], **Ford D.C.**[2], **Yonge C.J.**[3]

[1]UCSRT, University of Sofia, 5 James Bourchier Blvd., BG-1164 Sofia, Bulgaria

[2]Geography Department, McMaster University, Hamilton, Ontario L8S 1K4, Canada

[3]Department of Physics, University of Calgary, Calgary, Alberta T2N 1N4, Canada

We developed a new real-space periodogramme analysis algorithm to calculate, compare and calibrate the real intensity of the cycles in speleothem luminescence time series. We studied variations of the length of these cycles with time by evolutive power spectral analysis.

We studied long cycles in experimental proxy records of solar insolation from South Dakota, US and from Bulgaria 10000 km apart, covering 89300–138600 yrs B.P. and the last 250000 yrs respectively. These proxy records contain orbital cycles of 41, 23 and 19 kyrs and solar irradiance cycles with duration from several centuries to 11500 years. The most powerful non-orbital cycle is 11500 years cycle (as powerful as the 23000 a. orbital cycle in our record). It was found previously to be the most intensive cycle in the delta C-14 calibration record and was interpreted to be of geomagnetic origin. Our recent studies suggest that this is a solar cycle modulating the geomagnetic field. We determined the Solar origin of the cycles with durations of 11500, 4400, 3950, 2770, 2500, 2090, 1960, 1670, 1460, 1280, 1195, 1145, 1034, 935, 835, 750 and 610 years. It was done by their detection both in proxy records of speleothem luminescence, Δ^{14}C and the intensity of the geomagnetic dipole. The main variations in the last two records are produced by the solar wind. The longest solar luminosity cycles can produce climatic variations with intensity comparable to that of the orbital variations.

We used the same digital analysis to calculate the intensity of the cycles of solar insolation record derived from speleothems taken from Iowa and Alberta, USA. Obtained power spectra demonstrate that many speleothems recorded cycles of the soil temperature in the region with duration of about 11 and 22 years. These solar cycles produce variations of the solar constant with amplitude of less than 0.4% cosmic rays influence on the atmospheric transparency provides a mechanism of strong multiplication of solar variations on the solar radiation at the Earth's surface. Cosmic rays have strong modulation by the solar wind, which roles their concentration at the Earth.

Luminescence of speleothems from Rats Nest Cave, Alberta reproduce air temperature, but such records from this cave exhibit a strong cycle of 425 years, which is well known from Δ^{14}C to be an important solar cycle. So it should modulate air temperature as well as cosmic rays flux recorded by Δ^{14}C variations. The same records contain also the century and bi-century solar cycles.

In addition to the annual cycle produced by the Earth's rotation we found sub-annual cycles with duration of 27, 23 and 14 days in an extremely high-resolution luminescent record from Cold Water Cave, Iowa. Such cycles can be produced by the period of rotation of the Sun, which produces similar variations in the solar wind modulating cosmic rays flux. This period produces periodical appearance of the active zones on the Sun, which are major emitters of solar wind so produce strong variations of its density.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Ring Current Behavior Inferred from Ground Magnetic and Space Observations

Søraas F.

Department of Physics and Technology, University of Bergen, N-5007 Bergen, Norway

The precipitation of energetic ions and electrons into the upper atmosphere is a direct manifestation of their acceleration and pitch angle scattering in the magnetosphere. Electric fields inject/convect the particles from the tail plasma sheet towards the earth, and when closer to the Earth they spread in local time due to magnetic field forces. The electrons drift towards the morning sector and the ions towards the evening sector thus creating the RC (ring current). Certain aspects of the RC behaviour can be revealed by the precipitating energetic protons and electrons. From the protons a proxy for the energy injection rate into the RC can be estimated, and a RC-index which correlates highly with the pressure corrected Dst^* can be calculated.

The magnetic field at the Earth's surface exhibits an appreciable Magnetic Local Time (MLT) dependence in the initial and main phase of the storm. The field depression is very asymmetric, with the largest depression in the evening to midnight MLT sector. During

such storms a well defined Storm Time Equatorial Belt (STEB) of Energetic Neutral Atoms (ENA) and ions is found to exist at low altitudes around geomagnetic equator. Ring Current (RC) asymmetry and symmetry inferred from the STEB are in accordance with results from ground based magnetic observations. There is, however, also a difference. The magnetic observations show the storms to be worldwide, displaying essential the same signature all around the equator. The STEB is not worldwide it appears first in the midnight/evening sector and then it appears in the morning sector largely consistent with the drift of the RC ions.

Injection and loss processes of ring current particles will be discussed both through charge exchange and wave particle interaction.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Solar Cycle Variation of High-Speed Stream and Auroral Region Magnetic Activity

Tanskanen E.I.[1], **Nevanlinna H.**[1], **Pulkkinen T.I.**[2], **Pulkkinen A.**[3]

[1]Finnish Meteorological Institute, Space Reserach Unit, PO Box 503, FIN-00101 Helsinki, Finland

[2]Los Alamos National Laboratory, MS D466, Los Alamos, NM 87545, USA

[3]NASA Goddard Space Flight Center, Mail code 613, Greenbelt, MD 20771, USA

Auroral region magnetic activity is examined by using all-sky camera recordings from 1973 to 1997 and MIRACLE ground-based magnetic observations from 1993 to 2003. The occurrence of substorms is examined from magnetic observations over a complete 11-year solar cycle, identifying over 5000 substorms. It was found that substorm occurrence rate, peak amplitude and ionospheric dissipation (in the form of Joule heating and auroral electron precipitation) peaked in 1994–1995 and in 2003–2004, at 3–4 years after the sunspot maximum. High-speed streams were observed to occur repeatedly every 27 days during declining solar cycle phases, which suggest the close relationship between high-speed streams and substorms. Visual auroral observations based on the Finnish all-sky camera recordings show similar trend than substorms for higher activity during declining solar cycle phases compared to the other solar cycle phases. We discuss about the role of interplanetary Alfvénic fluctuations, occurring frequently during high-speed streams, to the increased auroral region activity.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Stratosphere and Ionosphere Effects by Solar Energetic Particles during Ground Level Enhancement on 20 January 2005

Tassev Y.[1], **Velinov P.**[1], **Spassov H.**[2], **Tomova D.**[1]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Geophysical Institute, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

The influences of major solar proton flare from 20 January 2005 on the ionized and neutral components in the stratosphere and lower ionosphere are analyzed. This flare is accompanied by ground level enhancement of solar cosmic rays and strong geomagnetic storm with SSC on 22 January 2005 (Kp index reaches 8). Short-term variations along the ozone profiles are discussed. Ozone data by satellite and ground based measurements are used. The GOES-10 satellite obtained the data on high energy protons. All energetic intervals 0.8–4 MeV, 4–9 MeV, 9–15 MeV, 15–40 MeV, 40–80 MeV, 80–165 MeV, 165–500 MeV are used. Cosmic ray data from super neutron monitors: Kiel – Germany (54.9; 95.6 geomagnetic degree) and Potchefstroom – South African Republic (-27.3; 90.1 geomagnetic degree) are analyzed also. Statistical analysis with this big volume of data is accomplished. Correlation and cross-correlation analysis between ozone and particle data is made. A different behavior of the ozone response in both hemispheres is obtained on the basis of these computations. The ionosphere results for the same period are obtained in the observatory Sofia, Bulgaria by means of A1 method. The minimal reflectance frequency $f_{\min}$, which characterizes the state of the lower ionosphere, has unusual course. The other ionosphere parameters (the critical frequency foF2, the height of the main ionosphere maximum *etc.*) show also anomalous behavior during the investigated period. The present investigation is an example for complex analysis of solar and extra-terrestrial influence in the middle atmosphere.

✓ OTHER RELATED TOPICS: POSTER

Kinetic Processes Responsible for Acceleration and Loss during Geomagnetic Storms

Thorne R.M.

Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, CA 90095-1565, USA

Enhanced magnetospheric convection during geomagnetic storms, causes the injection of plasmasheet ions and electrons into the inner magnetosphere, forming the stormtime ring current. Injected electrons, which drift towards the dawn-side, are unstable to the

excitation of whistler mode chorus over a broad spatial region outside the plasmapause. Injected protons, which drift towards the dusk-side, generate intense electromagnetic ion cyclotron (EMIC) waves, especially along the night-side plasmapause and within higher density drainage plumes in the afternoon sector. One important consequence of wave excitation is the scattering loss of ring current ions and electrons into the atmosphere. Such loss contributes to the global pattern of diffuse auroral precipitation. The excited waves also interact with relativistic electrons. Interaction with chorus emissions leads to stochastic energy diffusion and electron acceleration from ring current (100 keV) to MeV energies over a period of a day. Interaction with EMIC waves causes rapid scattering near the loss cone and ultimate loss to the atmosphere. The highly variable flux of relativistic electrons in the outer radiation belts is controlled by an imbalance between the source and loss process. The results of recent modeling of such processes will be discussed in this tutorial.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Currents to the Ionosphere over a Thunderstorm as Dependent on Cloud Electrification and Atmospheric Conductivity

Tonev P., **Velinov P.**

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

Electric fields and densities of conduction and Maxwell currents over a thunderstorm with recurrent lightning discharges are investigated theoretically. We consider the height region up to the ionosphere, in order to study better the role of thunderstorms on Earth as electrical generator in the global atmospheric circuit. Earlier investigations present evidence to suggest that the lightning-related charge redistribution and subsequent relaxation, rather than the high intensity current, is the source of the major component of the transient field and energy, coupled to the ionosphere. One of our goals is to study how the time course of total electrical current to the ionosphere and, at this end, the charge injected, is related to the thunderstorm electrification parameters, as well as to the atmospheric conductivity profile. An analytical quasi-static model is proposed, based on the Maxwell equations, by which the temporal and spatial behavior of the electric fields and of the conduction and Maxwell currents are computed. We consider a positive vertical dipole presentation of the electric structure of the thunderstorm, in which recurrent negative and positive cloud-to-ground discharges and intra-cloud discharges take place. Regularly repeating lightning discharges in a known proportion between the three different discharge types are assumed. Thunderstorm parameters of interest, on which the currents to the ionosphere depend, are: the lightning frequency (assumed to be constant in time for each discharge type), the lightning discharge characteristic time; the altitudes and magnitudes of the removed cloud charges and their characteristic horizontal size. Isotropic atmospheric conductivity is considered. Typically, the conductivity within a thundercloud is reduced up about an order, compared to conductivity of the adjacent air. This feature is also taken into account in the model. We study the efficiency factor of charging the ionosphere by a thunderstorm, as dependent on the total charge separation current in it. A conclusion is made by earlier models that the current to the ionosphere depends on the ratio between lightning currents of the cloud-to-ground and the intra-cloud discharges. According to our computations, this coefficient shows a dependence also on the lightning frequency, the altitude of the removed charge, and the conductivity in the charge vicinity. The efficiency decreases with the increase of the lightning frequency and by lower located removed charge. These results agree with some conclusions based on experimental data. An analysis is made of the influence to the currents into ionosphere by the solar activity cycle due to hypothetical long-term conductivity of higher troposphere and lower stratosphere.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Impact of Environmental Conditions on Thunderstorm Charging

Tsenova B.[1], **Mitzeva R.**[2], **Savtchenko A.**[2]

[1]National Institute of Meteorology and Hydrology, BG-1784 Sofia, Bulgaria

[2]Sofia University, Faculty of Physics, BG-1164 Sofia, Bulgaria

The environment temperature and moisture have deep influence on the microphysics and dynamics of the thundercloud and the cloud top. In some severe cases the last can penetrate the tropopause in manifestation of overshooting. Since the microphysics and dynamics have impact on the electrification of clouds, it may be expected that the environmental conditions would influence significantly the thunderstorm charging. Numerical model with parameterization of microphysics and non-inductive charging will be used for the simulations of three different cloud cases. The detailed analyses directed to the investigation of the impact of the environmental conditions (taken from aerological sounding) on the electrical structure of the simulated thunderstorms will be presented.

✓ OTHER RELATED TOPICS: POSTER

Factors in the Simulation of Large Solar Particle Events Produced by Fast Coronal Mass Ejections

Tylka A.J., **Hulburt E.O.**

Center for Space Research, Code 7652, Naval Research Laboratory, Washington, DC 20375, USA

Solar energetic particle (SEP) events are one of the prime challenges in modeling the Sun–Earth System. The largest SEP events, which occur at a rate of about 10 per year during solar maximum, pose radiation hazards that have direct implications for the design and operation of both manned and robotic space missions. The primary accelerators in these events are generally believed to be shocks driven by fast coronal mass ejections (CMEs), in which speeds are greater than about 1000 km/s. The successful simulation of these SEP events therefore requires understanding a wide range of issues, including the conditions in the corona and interplanetary medium, the evolution of CMEs and their shocks, and the details of energetic particle acceleration and transport. Because of the new instruments on ACE, SOHO, Wind, and other satellites, Solar Cycle 23 has given us an unprecedented treasure trove of information on energy spectra, elemental and isotopic composition, ionic charge states, and temporal evolution in SEP events, as well as the flares and CMEs that accompany them. I will review these results, with particular emphasis on their implications for SEP modeling efforts. I will discuss factors that will likely be important ingredients if these new modeling efforts are to succeed, including (1) evolution in shock characteristics as the CME moves outward from the Sun, (2) the role of flares in providing seed particles, and (3) the effects of proton-amplified Alfvén waves in particle transport.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

Global MHD Modeling of the Solar Wind

Usmanov A.V.[1,2], **Goldstein M.L.**[1]

[1]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

[2]University of Delaware, Newark, DE 19716, USA

A three-dimensional magnetohydrodynamic model is used to simulate the global structure of the solar corona and solar wind in the spherical shell between the coronal base and 100 AU. The model accounts for the effects of Alfvén wave acceleration near the Sun and for the interaction of solar wind protons with interstellar neutral hydrogen in the outer heliosphere. We use the time-relaxation method to construct a steady-state solution of time-dependent equations in the inner computation region (1–20 solar radii) and a direct integration along radius of steady-state equations outside 20 solar radii. The relaxation code is an implementation of the spatially third-order, semi-discrete Central Weighted Essentially Non-Oscillatory (CWENO) numerical scheme of Kurganov and Levy [2000]. We present simulation results for the solar conditions typical of solar minimum and other phases of the solar cycle.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Monte-Carlo Simulations of Shock Acceleration of Solar Energetic Particles in Self-Generated Turbulence

Vainio R.[1], **Laitinen T.V.**[2]

[1]Department of Physical Sciences, University of Helsinki, FIN-00014 Helsinki, Finland

[2]Department of Physics and Väisälä Institute for Space Physics and Astronomy, University of Turku, FIN-20014 Turku, Finland

Acceleration of solar particles by shock waves up to relativistic velocities has puzzled the researchers for several decades. Understanding the acceleration process requires knowledge of the interplay between the particles and the plasma waves that scatter them in the vicinity of shock waves. In small events, these interactions are relatively simple, and modeling of the acceleration can be achieved via simple test-particle simulations. In larger events, however, the energetic particles begin to influence the plasma turbulence through a streaming instability, which subsequently enhances the acceleration process.

In this work, we study energetic particle acceleration in CME-driven shock waves by simultaneously tracing the evolution of a large number of particles and the Alfvénic turbulence responsible for their scattering. We allow the particles to self-consistently determine the turbulence strength and, thus, the subsequent rate of particle acceleration at a CME-driven shock. The ambient and generated turbulence is transported radially according to the WKB approximation, supplemented with linear diffusion in the wavenumber space. Using this model, we can obtain efficient wave growth and particle acceleration to energies beyond 100 MeV in a few hundred seconds in large particle events. As expected, when the injection of the low-energy particles is strong enough, the generated turbulence traps a large portion of the particles into the vicinity of the shock, causing the s.c. streaming limit effect in the intensities observed at a distance from the shock. We present a parameter study of the efficiency of acceleration, defined by acceleration time scales and attainable particle energies, by varying the shock and particle injection parameters. We will also investigate how this phenomenon affects the observable onset and evolution of the particle event as observed in the vicinity of the Earth.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

RAM Model with a Non-Dipole Magnetic Field: Initial Results, Calculation of Bounce-Averaged Velocities and Hydrogen Densities

Vapirev A.[1], **Jordanova V.K.**[2]

[1]Space Science Center, University of New Hampshire, Durham, NH 03824, USA

[2]Los Alamos National Laboratory, Los Alamos, NM 87545, USA

We present initial results with the RAM model updated for non-dipole time-dependant magnetic field configuration. We numerically calculate the corresponding integrals for the bounce period and the second adiabatic invariant. We use the same numerical technique to calculate the bounce-averaged Hydrogen densities and the bounce-averaged magnetic gradient-curvature drift velocities. Then we calculate the relative difference for the above quantities and those for a dipole field for various geomagnetic conditions. We find that the relative difference for the bounce-averaged Hydrogen densities is around 10% for quiet time, while for disturbed it may exceed 20% at large L shells on the nightside. The corresponding results for the bounce-averaged velocities are respectively between -50% on the nightside and 20% on the dayside during quiet time, and between -80% and 40%, respectively during disturbed time. We use then the above results to simulate the geomagnetic storm of May 1997. Our results show good comparison with the simulation for dipole field when the magnetic configuration is not strongly disturbed.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

Relativistic Electron Enhancement Rise Times from *L* = 4–6 as Measured by the GPS Energetic Instrument Constellation

Varotsou A., **Friedel R.H.W.**, **Cayton T.E.**, **Ingraham J.C.**

Los Alamos National Laboratoty, Space and Atmospheric Sciences Group (ISR-1), Los Alamos, NM 87545, USA

With simultaneous energetic electron data from LANL instruments aboard 6 GPS satellites we are now obtaining a very detailed spatial and temporal coverage of the outer radiation belt from $L = 4$ outward in the energy range of 100 keV to several MeV. This allows us to create time series of measurements at fixed L with sub-hour time resolution which allows for a detailed investigation of the energetic electron rise times observed during enhancement events, mostly in the recovery phase of geomagnetic storms. The most dramatic response in the outer radiation belt is often seen near $L \sim 4.5$, with enhancements of two orders of magnitude observed over a 1–2 day period, followed by diffusion both inward (slow) and outward (fast).

We present here a statistical study of enhancement events seen since November 2004 (4 instruments on orbit) and investigate the behavior of enhancement rise times as a function of L. We intend to use this information to test the viability of proposed acceleration mechanisms such as whistler chorus acceleration, ULF wave pumping or simple radial diffusion.

✓ PRODUCTION, TRANSPORT, AND LOSS OF ENERGETIC PARTICLES: ORAL

3D Modeling of Cosmic Ray Ionization in the Oblate Giant Planet Atmospheres, Approximated by Rotation Ellipsoids

Velinov P.[1], **Ruder H.**[2], **Mateev L.**[1], **Kostov V.**[1]

[1]Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

[2]Institut für Astronomie und Astrophysik, Eberhard-Karls-Universität Tübingen, D-72076 Tübingen, Germany

As a continuation of our investigations of ellipsoidal Chapman (Che) function of the atmospheres of oblate planets (Velinov *et al.*, ASR, 2004) we present new calculations for the giant planets Jupiter, Saturn, and its satellite Titan, Uranus and Neptune. In the above mentioned paper Che function only for the north and south pole regions is presented. There, some computations for Che function for the ionosphere of Saturn (only on latitudes $\pm 90^\circ$) at different altitudes and solar zenith angles: 45°, 60°, 75°, 80°, 83°, 85°, 87°, 90°, 93°, 95°, 97° and 100°, are made. This new paper presents the results of our work on the ellipsoidal Chapman function of oblate planetary bodies. Here the calculations for Che function in the oblate planet atmospheres of giant planets from Jovian group for middle and lower latitudes (including the equator) in Tables are presented. Che function for a rotational ellipsoid depends on the oblateness and on the solar zenith angle, altitude, latitude and the solar declination. A comparison between Che function and classical Chapman function Ch for a spherical planet is made. The last function is applicable for the ionospheres of terrestrial planets (Venus, Earth and Mars). This comparison shows the necessity of introducing Che function in numerical analysis of ionospheres of Jupiter, Saturn and Titan, Uranus and Neptune. The function Che determines more precisely the optical depth parameter for solar XUV radiation and also the particle depth parameter for galactic and solar cosmic ray particles. The difference between evaluations of electron production rate profiles with Che and Ch functions are particularly significant at larger zenith angles (90°–100°), *i.e.* in sunrise–sunset periods. We developed 3D model for CR ionization in oblate planet atmosphere, approximated by rotational ellipsoid. This 3D model generalizes

our considerations for spherical atmospheres of terrestrial planets. In the case of giant planets from Jupiter group we make additional integration by azimuth angle in the general expression for electron production rate profiles.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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Cosmic Ray Influence on the System Ionosphere–Atmosphere through Ionization, Chemical and Electrodynamic Processes. CR as Key Governing the Sun–Earth Connections

Velinov P.

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-1113 Sofia, Bulgaria

Cosmic Rays (CR) are the relativistic plasma in the Universe. There are the following CR types:

1. Galactic CR, with energies until 10^{15} eV, which are accelerated in the space of our Galaxy.
2. Metagalactic CR with energies 10^{15}–10^{21} eV, accelerated in the Metagalaxy.
3. Solar CR, accelerated on the Sun.
4. Anomalous CR, accelerated in the interplanetary space.

CR are important for the Sun–Earth connections, because they possess maximal penetration capabilility in comparison with the other radiations. CR maintain ionization in the ionosphere, atmosphere, hydrosphere, cryosphere and lithosphere of the Earth and planets. CR determine the ionization rate $q(h)$ and electron density $N(h)$ profiles in the iono/atmosphere and also the conductivities there. The last influence on the electric processes, *i.e.* thunderstorms, Earth's global charge and global electric circuit between the ground and the ionosphere. CR particles produce also nuclear reactions with air, water and ground atoms. On this way cosmogenic nuclides in the environment are created.

All this shows the significance of CR in the Sun–Earth connections. That is why we develop one improved theoretical model for the CR ionization in the iono/atmosphere. First we model the spectra of different primary CR groups of nuclei: protons ($Z = 1$), alpha particles ($Z = 2$), light L ($Z = 3$–5), median M ($Z = 6$–9), heavy H ($Z = 10$–19), very heavy VH ($Z = 20$–29) and super heavy SH (Z more than 29) groups. We take into account the CR modulation by solar wind and the anomalous CR component also. $q(h)$ is determined by the solution of a 3D integral with 4th integration in the integrand function with account of geomagnetic cut-off rigidity. We calculate $q(h)$, $N(h)$ and conductivity tensor at quiet and disturbed (geomagnetic storms with SSC and solar CR) conditions.

These solar CR effects are important in the stratosphere, mesosphere and lower thermosphere. The influences of the solar proton flares on the ionized and neutral (including ozone) components in the stratosphere and lower ionosphere are investigated. CR transmit in the ozonosphere their solar modulation. But the ozone controls the meteorological solar constant and the thermal regime and dynamics of the lower atmosphere, *i.e.* the weather. This mechanism of the Sun–Earth connections shows the way to a non-contradictory solution of key problems of the solar-terrestrial physics.

The $q(h)$ model is generalized for the planets from Jovian group (Jupiter, Saturn and its satellite Titan, Uranus and Neptune), which are approximated by rotational ellipsoids. For this purpose we introduce an ellipsoidal Chapman (Che) function of the oblate planet atmospheres. We make additional integration by azimuth angle in the general expression for $q(h)$ profiles. The function Che determines more precisely the optical depth parameter for solar XUV rays and also the particle depth parameter for CR particles. A comparison between evaluations of $q(h)$ with Che function and classical Chapman function Ch for a spherical planet is made. The last function is applicable for the ionospheres of terrestrial planets (Venus, Earth and Mars). The comparison shows necessity of introducing the Che function in analysis of giant planets.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

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Electron Density Enhancement Events in Magnetic Flux Tubes

Veselov M.[1], **Lukianova R.**[2], **Zinin L.V.**[3]

[1]Space Research Institute, RU-117997 Moscow, Russia

[2]Arctic and Antarctic Research Institute, RU-199397 St. Petersburg, Russia

[3]Kaliningrad State University, RU-236041 Kaliningrad, Russia

The knowledge of thermal plasma concentration, acceleration and heating mechanisms is very important for many applications in magnetospheric physics. As the ionosphere is a main reservoir of plasma in the magnetosphere, the density of ionospheric population of thermal plasma often dominates over solar wind plasma in the inner magnetosphere. To understand processes in magnetosphere it is necessary to know the dynamics of thermal plasma motion both across and along the magnetic field, and its acceleration to higher energies. However, a detailed and quantitative assessment of the various processes which drive the ion outflows still appears to be a very wide and open question. Along with well known but poorly investigated "polar wind" – ionospheric ions escape along magnetic field

line driven solely by pressure gradients of electrons and ions, there are several mechanisms providing additional heating of electrons and their primary escape, what, in its turn, produces field-aligned electric field working as "ion exhauster" for low energy ionospheric ions. Experimental data analysis allows underline some of them. First, the flux tube convection over dayside cusp vicinity and its long stay there driven by IMF By component sharp variations is considered. Suggested model adequately describes convection pattern and is in a good agreement with experimental data. Another very interesting mechanism is a terminator passage by magnetic flux tube due to large-scale convection, where sharp photo-ionization in F-layer takes place. Simulating of this effect by means of multi-ion time-dependent quasi-MHD model of flux tube density evolution TUBE-7 illuminates its significant contribution to flux tube filling dynamics by ionospheric ions. Detailed description of such localized effects and their following inclusion to global models of seems to be a proper way to increase the level of our knowledge on ionosphere-magnetosphere coupling processes.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Plasma Dynamics in the Earth Magnetosphere during Periods of Enhaced Activity

Vovchenko V.V., **Buzulukova N.Yu.**

Space Research Institute, RU-117997 Moscow, Russia

Numerical calculation of self-consistent electric fields ('outer' electric field – driven (via polar cap potential) by solar wind, and 'inner' electric field – driven by 'hot' plasma sheet plasma population) is made to define electric field pattern. Proposed numerical model consist of severalmodules: 1) calculation of field-aligned currents from closure of transverse drift currents arising from "hot" plasma motion; 2) calculation of ionospheric electric field potential under obtained field-aligned currents and given ionospheric conductivity model; 3) calculation of drift trajectories of plasma sheet particles motion in the inner magnetosphere under obtained electric and given magnetic fields. The electric field pattern corresponding to some specific cases of outer boundary electric field potential is considered: 1) constant in time potential; 2) potential increase; 3) potential decrease; 4) several different step-like functions.

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✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

Observation of a Plasma Depletion Layer during Southward Interplanetary Magnetic Field

Wang N.[1], **Chen T.**[1], **Liu Z.**[1], **Shi J.**[1], **Luo J.**[1], **Balogh A.**[2], **Carr C.**[2], **Zhang T.**[3], **Reme H.**[4], **Gustafsson G.**[5], **Fazakerley A.N.**[6]

[1]Center for Space Science and Applied Research, Academia Sinica, Beijing 100080, China

[2]The Blackett Laboratory, Imperial College, London SW7 2BZ, UK

[3]Space Research Institute, Austrian Acadimy of Sciences, Schmiedlstrasse 6, A-8042 Graz, Austria

[4]CESR, BP 4346, F-31028 Toulouse Cedex 4, France

[5]Swedish Institute of Space Physics, Uppsala Division, SE-751 21 Uppsala, Sweden

[6]Mullard Space Science Laboratory, University College London, Holmbury Sr. Mary, Dorking, Surry RH5 6NT, UK

A big magnetic storm with Dst of order -472 nT occurred on November 20, 2003. Cluster spacecrafts passed through the magnetopause (MP) at 16:13:20 on the dusk flank. During big magnetic storm a PDL (Plasma depletion layer) was observed on the dusk magnetosheath when the IMF was southward. A model of the formation of the PDL has been dicussed. The variation of the density is anti-correlative with the proton bulk velocity in the PDL. The acceleration of the flow is observed in the PDL, and the flow is accelerated further in the MP crossing. The dusk electric field component E_{dusk} was simultaneously observed. The E_{dusk} is about of order 20–70 mV/m during big magnetic storm, but the E_{dusk} is about of order ± 8 mV/m during magnetic quiet time. The behaviors of plasma ans field during big magnetic storm are different than ones at magnetic quiet time on the MP and PDL. A PDL is not observed on the dusk magnetosheath during magnetic quiet time when the IMF is southward.

✓ CLUSTER OBSERVATIONS AND THEORY: POSTER

Model of Ion Escape from Topside Polar Ionosphere

Watanabe S., **Yamada M.**

Department of Earth and Planetary Sciences, Hokkaido University, Kitaku, Sapporo 060-0808, Japan

A model of topside polar ionosphere was made on the bases of data obtained by Suprathermal Ion Mass Spectrometer (SMS) on Akebono satellite. The SMS measures ion energy distributions in the energy range from 0 to 25 eV and in the mass range from 1 to 64 m/q. The satellite continues to observe the topside polar ionosphere in the periods more than one solar cycle from 1989. Model

functions in the 5 dimensional space were fitted to the data, such as plasma parameters of density, velocity and temperature of H^+, He^+ and O^+, with a least square method. The empirical model of topside polar ionosphere is obtained as functions of magnetic latitude, magnetic local time, altitude, F10.7 solar flux intensity and geomagnetic activity. The modeling shows clearly both solar and geomagnetic activity dependences of ion density and ion escape flux from topside polar ionosphere to the magnetosphere. The flux exceeds more than 10 tons/day. We suggest that the ion escape from ionosphere is one of the source mechanisms of magnetospheric plasma and affects the dynamics of ring current.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Study of the Latitude Distribution of the Ozone Variability by Wavelet Application

Werner, R.

Solar-Terrestrial Influences Laboratory, Bulgarian Academy of Sciences, BG-6000 Stara Zagora, Bulgaria

The ozone variability at time scales of the solar rotation was studied using zonal averaged total ozone column (TOC) TOMS data. For a latitude sequence of time series the Mexican hat wavelet spectra for periods up to 55 days were calculated. The wavelets were averaged over a period interval from 24 up to 34 days, which are typical for solar activity variations caused by the solar rotation. By the help of the averaged wavelet spectra, a Hovmöller (latitude–time) diagram of the wavelet variance for TOC was constructed. The results were compared with the solar rotational activity variation.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Time-scales for the Formation of the Cold-Dense Plasma Sheet

Wing S., **Fujimoto M.**

[1]Johns Hopkins University, Laurel, MD 20723-6099, USA

[2]Tokyo Institute of Technology, Tokyo 152-8550, Japan

The plasma sheet becomes cold and dense during periods of northward IMF, as a result of a large influx of magnetosheath ions. During these periods, plasma sheet ions often have two components: hot (magnetospheric origin) and cold (magnetosheath origin). The cold-component constituent of the two-component ions is hotter in the dawn than the dusk sector, consistent with in situ studies that suggest that the magnetosheath ions are heated during the entry process along the plasma sheet dawn flank. This temperature asymmetry leads to a dawn-dusk asymmetry in the ion spectral distribution. An interplanetary magnetic cloud event in which the IMF stays northward for almost 24 hours is presented. During this event, Geotail satellite was mostly inside the plasma sheet and four DMSP satellites, F11, F12, F13 and F14, were operational simultaneously. In this event, the plasma sheet was initially hot and tenuous, and then it turned cold and dense before turning back to hot and tenuous again. This event provides an excellent opportunity to study the time-scales for the plasma sheet to reach cold and dense state after IMF northward turning and to reach hot-tenuous state after IMF southward turning.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Solar Cycle Effects in Geomagnetic Activity Forecasting

Wing S.[1] **Johnson J.R.**[2]

[1]Johns Hopkins University, Laurel, MD 20723-6099, USA

[2]Princeton University, Princeton, NJ 08544, USA

The Kp index has been used as a proxy for global geomagnetic activity level. Cumulant based analysis of Kp from 1932 to 2003 reveals linear and nonlinear correlations of $Kp(t)$ and $Kp(t-\tau)$. The linear correlation peaks at $\tau = 0$ hour and drops off rapidly after a few hours, suggesting that the persistence in Kp is in the order of a few hours. While the linear response is roughly the same for solar minimum and solar maximum, there is sharp difference in the nonlinear response. Near solar maximum, the nonlinear correlation follows closely the behavior of the linear correlation. In contrast, near solar min, the nonlinear correlation has a peak at $\tau = 0$ hour and a secondary peak around $\tau = 40$ hours. In fact, the nonlinear response appears to roughly anti-correlate with the sun spot number in every solar cycle since 1932. Several solar wind driven Kp forecast models were evaluated with data that spans over two solar cycles, 1975–2001. The evaluations show that the models predict Kp more accurately during solar maximum than solar minimum. All together, the results suggest that geospace is more dominated by internal dynamics during solar minimum than solar maximum, when it is more directly driven by external inputs, namely solar wind and IMF.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Auroral Precipitation Power during Substorm: an Empirical Model Based on DMSP F6 and F7 Spacecraft Observations

Yagodkina O.I., **Vorobjev V.G.**

Polar Geophysical Institute, RU-184200 Apatity, Russia

In this report an energetic model of auroral precipitation during substorm is presented. This model is based on the statistical treatment of electron precipitation characteristics obtained with DMSP F6 and F7 spacecraft. Auroral boundary positions and average electron precipitation flux during all substorm phases have been used to calculate the precipitation power. The power contribution was found for an average substorm of about 400 nT intensity in all 3-hour sectors of MLT and separately for three different auroral regions: diffuse auroral zone (DAZ), structured auroral oval precipitation (AOP) and soft diffuse precipitation (SDP) poleward of the AOP. It is shown that there is a significant increase in precipitation power both on the day and night sides of the Earth during the substorm growth phase from the quiet level of about 0.7 GW to 1.2 GW in the 09–12 MLT sector and from about 0.8 GW to 2.6 GW in the 21–24 MLT sector, respectively. On the dayside the greatest energy was observed in the DAZ during the final stage of substorm recovery phase with the maximum of about 1.8 GW in the pre-noon. On the nightside the greatest precipitation power was registered in the AOP during the final stage of substorm expansive phase with the maximum of about 15 GW in the pre-midnight. In the DAZ region the peak in precipitation power occurs in the 06–09 MLT sector. In the SDP region the electron precipitation is more powerful on the dayside than on the nightside, while the opposite is held in the AOP region. One hemisphere global precipitation power was found to be about 9 GW, 19 GW and 61 GW for the quiet level, in the final stage of substorm growth phase and at the end of substorm expansion correspondingly. Our model makes it possible to calculate the average precipitation power during all substorm phases of any intensity in the AL index. Thus, the quantitative estimates of global precipitation power at the final stage of substorm expansive phase were about 30 GW for $|AL| = 150$ nT and 140 GW for $|AL| = 1000$ nT.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: POSTER

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The Probable Effects of Interplanetary Magnetic Field on the F-Layer Critical Frequency

Yapici T.[1], **Tulunay Y.**[2]

[1]Department of Aerospace Engineering, Middle East Technical University, TR-06531 Ankara, Turkey

[2]METU, Department of Electrical and Electronic Engineering, TR-06531 Ankara, Turkey

Magnetosphere and ionosphere are highly in contact with each other. The magnetospheric field lines induce currents in the ionosphere depending on the magnitude of the conductivity. It was mentioned by Troshichev (2005) that the current should be analyzed in regions of three. First two currents (region 1 and region 2 currents) are controlled by IMF B_z component. On the other hand, region 0 current, which is current located poleward, is strongly dependent on the IMF By component. Since ionospheric currents have a crucial effect on the maximum electron density, critical frequency, which is the maximum frequency of a radio wave that can be reflected from the ionosphere, is well influenced (Davis *et al*., 1996). Thus, IMF By component should be taken into account on the consideration of variability of the ionosphere. In this study, one of the aims was to investigate the probable effects of the interplanetary magnetic field on the Flayer critical frequency by the application of superposed epoch method. Depending on the ionosonde selection, the contribution of geomagnetic conjugacy was also analyzed. The effects were determined in terms of the critical frequency, foF2, and the geomagnetic indices, which are Kp and AE. Data interval selected covers a period of 1975 to 1986 (21st solar cycle) for the completeness of data-set and full understanding of the physics of the nature. Superposed epoch study was employed depending on the calculated diurnal variation of foF2 (control curve). The diurnal variation in the foF2 data were removed by subtracting the mean of foF2 for the same UT on all the magnetically quiet days ($Kp < 2+$) within 15 days around the IMF B_z turnings events for IMF B_z effects. "IMF B_z turning events" were identified by three criteria, (1) southward polarity change, (2) $|B_z| = 11$ nT, (3) preserving the polarity for 3 hours before and after polarity change. Relying on the definition, 41 events were identified. Same procedure, starting from the control curve computation continuing with the event definition, was employed for the IMF By effects. Since the IMF By controls different physical phenomena, the event definition was different from the IMF B_z event definition. It was observed that Kp index shows rises before IMF Bz events and it takes time to decay and go back to quiet period. Moreover, the rising period was seen to be relatively short then the decaying period. Similar characteristics were observed for IMF B_z values. For a IMF B_z event, before an event, IMF B_z increases in the northward direction and suddenly reverses to southward direction. Average values of peaks were found to be at $\sim$11 nT and ~ -12 nT, giving an average change of $\sim$23 nT. Around the specified events, $-4/+4$ days averages of foF2 were computed, revealing 1 MHz of decrease for foF2 within 20 hours after the event.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Solar Wind Parameters for CIR-Induced and ICME-Induced Magnetic Storms

Yermolaev Yu.I., **Yermolaev M.Yu.**, **Nikolaeva N.S.**, **Lodkina I.G.**

Space Research Institute, Russian Academy Sciences, RU-117997 Moscow, Russia

A brief review on comparison of conditions in the interplanetary space during geomagnetic storms which are usually generated by 2 large-scale interplanetary phenomena – interplanetary coronal mass ejection (ICME) and corotating interaction region (CIR) is presented. ICMEs (or magnetic clouds) are sources of stronger magnetic storms. We take into account that 2 parts of ICME may be geoeffective – compressed region between shock and leading edge of ICME (Sheath) and the body of ICME. We use superposed epoch method with storm onset time as zero time for analysis of 628 magnetic storms. Stronger storms are usually generated by the sheathes but not by the body of ICME. Behavior of plasma and magnetic field parameters in CIR and Sheath is close to one in ordinary solar wind while in ICME it may significantly differ. For example, in ICME the magnitudes and variations of proton temperature, total ion density, minor ion abundance, beta-parameters and others differ from onces in CIR and Sheath. These facts may be used for modeling CME formation and dynamics as well as for forecasting the Space Weather conditions near the Earth. Paper is support in part by Physical RFBR, Grant 04-02-16131.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

Magnetic Storm Dependence on Solar and Interplanetary Events: Statistic Study

Yermolaev Yu.I., **Yermolaev M.Yu.**, **Zastenker G.N.**, **Petrukovich A.A.**, **Zelenyi L.M.**

Space Research Institute, Russian Academy Sciences, RU-117997 Moscow, Russia

In our talk we continue discussion of geoeffectiveness (possibility to generate magnetic storms on the Earth) of solar and interplanetary disturbances (see Yermolaev *et al.*, Planet. Space Sci., 2005). In the literature on the solar–terrestrial relations there are different estimations of storm effectiveness of solar and interplanetary events – from 30 up to 100%. Different results arise due to differences in the methods used to analyze the data: (1) the direction in which the events are compared, (2) the pair of compared events, and (3) the methods of the event classifications. We selected papers using (1) the analysis on direct and back tracing of events, and (2) solar (coronal flares and CMEs), interplanetary (magnetic clouds and ejecta) and geomagnetic disturbances (storms on Dst and Kp indices). The classifications of magnetic storms by the Kp and Dst indices, the solar flare classifications by optical and X-ray observations, and the classifications of different geoeffective interplanetary events are compared and discussed. Taking into account this selection, all published results on the geoeffectiveness agree to each other in each subset: "CME to Storms" – 40–50%, "CME to MC, Ejecta" – 60–80%, "MC, Ejecta to Storm" – 50–80%, "Storm to MC, Ejecta" – 30–70%, "MC, Ejecta to CME" – 50–80%, "Storm to CME" – 80–100%, "Flare to Storms" – 30–40% and "Storms to Flare" – 50–80%. Higher values of correlations were obtained by back tracing, that is, by method, in which they were defined as the probability of finding candidates for a source of geomagnetic storms among CMEs and flares, and, strictly speaking, these values are not true estimates of the geoeffectiveness. The latter results are also in contrast with the results of the two-stage tracing of the events: first a storm – an interplanetary disturbance, and then an interplanetary disturbance – a CME/flare. Paper is supported in part by RFBR, Grant 04-02-16131.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: ORAL

Magnetic Storm of November, 2004: Solar, Heliospheric, and Magnetospheric Disturbances

Yermolaev Yu.I.[1], **Zelenyi L.M.**[1], **Kuznetsov V.D.**[2], **Chertok I.M.**[2], **Panasyuk M.I.**[3], **Zhitnik I.A.**[4], **SEE'04 Collaboration Team**

[1]Space Research Institute, Russian Academy Sciences, RU-117997 Moscow, Russia

[2]St. Petersburg Branch of the Institute of Terrestrial Magnetism, Ionosphere and Radiowave Propagation, Russian Academy Sciences, RU-191023 St. Petersburg, Russia

[3]Skobeltsyn Institute of Nuclear Physics, Moscow State University, RU-119992 Moscow, Russia

[4]Lebedev Physical Institute, Russian Academy of Sciences, RU-119991 Moscow, Russia

We present and discuss main data on observations of the Sun, interplanetary medium, and magnetosphere, obtained before and during the strongest magnetic storm with $Dst = -373$ nT on November 08, 2004 (see preliminary version in paper by Yermolaev *et al.*, A Year Later: Solar, Heliospheric, and Magnetospheric Disturbances in November 2004, Geomagnetism and Aeronomy, Vol. **45**, No. 6, 2005, `http://solarwind.cosmos.ru/txt/gma681.pdf`). These events were observed in year after the series of the strongest solar flares (including flares of class $>$ X17) and the magnetic storm with $Dst = -401$ and -472 nT during October–November 2003. Although the number and power of the flares were much smaller during the period under study, the magnetic storm was one of the strongest for the entire period of observation of the Dst index and was apparently caused by the interaction of frequently

occurred coronal mass ejections in the interplanetary space, as a result of which the region of interaction compressed and the southern IMF component increased to less than -45 nT. Paper is supported in part by RFBR, grant 04-02-16131.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: POSTER

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The Expected Recovery of the Ozone Hole in Response to Solar Weak Cycles

Yousef S.[1], **Al-Kuhaimi S.A.**[2], **Bebars A.**[3]

[1]Astronomy and Meteorology Department, Faculty of Science, Cairo University, 12613 Giza, Egypt

[2]Girls College of Education, Scientific Department, Malaz, Riyadh 11417, Kingdom of Saudi Arabia

[3]National Research Institute of Astronomy and Geophysics, Helwan 11421, Cairo, Egypt

A prolonged period of reduced solar activity of the order of few decades is expected owing to the presence of weak solar cycles series like those around 1800 and 1900 AD. Reduced UV flux is forecasted.

The multitude of phytoplankton in the Antarctic ocean which are harmed by excessive UV passing through the ozone hole are expected to recover owing to the reduced solar UV doze even with the existence of ozone hole. An increase of only 10% of the phytoplankton would remove about 5 gigatons of carbon from the atmosphere annually (which is equal to the amount of carbon dioxide emitted currently by fossil fuel utilization) and sink it into the ocean. Reduction of carbon dioxide from the atmosphere will lead to cooling of the troposphere and hence warming of Antarctic stratospheric clouds which are the sight of ozone destruction. Eventually, this procedure will hopefully lead to Antarctic ozone hole closure.

The paper also discuss the implication of the 1997 solar induced climate change on the appearance of the Arctic ozone hole and the reduction of the Antarctic ozone hole.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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On a Solar Forcing Mechanism on the General Wind Circulations

Yousef S.

Astronomy and Meteorology Department, Faculty of Science, Cairo University, 12613 Giza, Egypt

It is suggested that the influence of coronal mass ejections impacts on the Earth can influence the weather through compression of the magnetosphere (maximum 50%). This compression by the accompanying shock wave is likely to propagate downward to the troposphere.

The second most important effect is the entering of the accompanying proton and electron streams from the night side of the Earth via the Van Allen belt into the two Polar Regions. This will lead to heating of the polar atmospheres, expanding the air and thus intensifying the anticyclones.

In the case of the Arctic region, the Icelandic low will be deepened

This will alter the NAO and consequently alter the wind circulation in the Mediterranean regions particularly, affect the Euphrates discharge, northern Europe and eastern united states.

It is suggested that the bombardment of solar protons to the polar regions have different effect to the bombardments by electrons, having opposite charges which will be reflected on atmospheric electricity. This might be connected to the polar ionospheric currents which are of the order of millions of amperes. The case of Mecca deluges On January 2005 is related to very strong proton fluxes attacking the Earth from the Polar Regions and extended to lower latitudes thus intensifying the Siberian high. Additional examples will also be given.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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The 51 Year and the 22 Year Hale Solar Cycles and Their Implications on Terrestrial Environment

Bebars E.[1], **Yousef S.**[2]

[1]Helwan Obsevatory, National Research Institute of Astronomy and Geophysics, Helwan 11421, Cairo, Egypt

[2]Astronomy and Meteorology Department, Faculty of Science, Cairo University, 12613 Giza, Egypt

The 22 and the 51 years solar cycles are very prominent in various terrestrial factors. Those two solar stimuli are evident in cyclones and, temperature series. Analysis of Nile series between 622–1468 AD.

Indicates a -0.8 cross correlations for a period of 80 years which changes to positive correlation for the next 51 years. A search of those two indices will be presented in different atmospheric indices, biological time series and proxy data.

'In the heavens are your sustenance and what you are threatened with' 51:22 the Holy Quran.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM

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Magnetically Self-Consistent Simulations of the Near-Earth Geospace Response During Storms

Zaharia S., **Jordanova V.K.**, **Thomsen M.F.**, **Reeves G.D.**

Space Science and Applications, Los Alamos National Laboratory, Los Alamos, NM 87545, USA

Observations and simulations alike indicate that during geomagnetic storms the magnetic field in the night-side inner magnetosphere is very stretched compared to that of a dipole; therefore, a magnetically self-consistent treatment of plasma transport is crucial during such events. In this work we present recent improvements to our self-consistent approach to modeling the response of the near-Earth geospace during storms. Our approach consists in a 2-way coupling between a kinetic ring current model and a 3D plasma equilibrium model. The coupled model computes the magnetic field in force balance with the anisotropic pressure distributions from the kinetic model, and then feeds the field back into the kinetic model to guide its continued evolution. The kinetic model uses boundary and initial conditions based on spacecraft observations. Recent improvements in our approach include 1) implementing a full coupling between the 2 constituent models (plasma and field are coupled every 10 minutes), rather than our initial iterative procedure; and 2) employing magnetic flux boundary conditions for the equilibrium model from the newer, more realistic TS04 empirical field model, specifically designed for storm conditions. We apply our self-consistent approach to simulating actual geomagnetic storms. We will discuss the differences between the obtained self-consistent results (including findings of lower plasma transport and plasma pressure in the inner magnetosphere) and those from runs of the kinetic model with a dipolar field, as well as the physical reasons behind those differences. We will also present comparisons between the coupled model output and spacecraft plasma and magnetic field observations.

✓ SUN–EARTH SYSTEM MODELING AND PREDICTION: ORAL

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The Interaction of the Interstellar Medium with the Sun: Coalescence of Plasma Physics, Space Physics, and Astrophysics

Zank G.P.

Institute of Geophysics and Planetary Physics, University of California, Riverside, CA 92521, USA

The local interstellar medium (LISM) plays an influential role in the physics of the outer heliosphere and is instrumental in determining the large-scale structure of the heliosphere. The basic physics of the solar wind - LISM interaction will be reviewed and the global structure of the heliosphere will be described. The critical role of neutral interstellar atoms will be emphasized. The modeling of the interaction of the partially ionized local interstellar medium with the solar wind is complex and rich in details. An ideal model on global heliospheric scales typically includes the magnetohydrodynamics of the encounter of two hydrogen plasma winds (solar and interstellar wind, with magnetic fields), modified by the interaction with neutral atoms of interstellar origin. This nonlinear interaction gives rise to feedback on the plasma distributions via the pickup process, and to an essentially non-Maxwellian neutral distribution function throughout the heliosphere. The latter requires a complex treatment of the neutrals in the numerical models. We give an overview of current efforts to model the global heliosphere and some key results, including the filtration of interstellar neutrals at heliospheric boundary regions before entering the inner heliosphere. Recent results related to the time-dependence of the heliosphere, the instability of the heliopause, the inclusion of the interplanetary and interstellar magnetic fields, a more sophisticated treatment of collisional effects, and the incorporation of galactic cosmic rays will be described.

A suite of observations, (i) Lyman-alpha absorption spectra towards nearby stars; (ii) the predicted timing of the turn-on of radio emissions in the outer heliosphere; (iii) solar cycle variation in the solar wind ram pressure and the frequency with which interplanetary shocks occur, (iv) pickup ion and neutral atom measurements, (v) and Voyager observations will be used in an attempt to constrain heliospheric global structure and the plasma physical processes governing the outer heliosphere. We will conclude with (i) an historical perspective of the travels of the Sun through the galaxy, emphasizing the possibility that the Sun experienced many different environments, suggesting that heliospheric conditions are constantly changing and may have been very different in times past (and future!), and (ii) the implications of these results for other stars in different interstellar environments.

✓ SOLAR DYNAMICS AND THE RESPONSE OF GEOSPACE: ORAL

Spectral Line width Decrease in the Solar Corona: Resonant Energy Conversion from Alfvén to Acoustic Waves

Zaqarashvili T.[1], **Oliver R.**[2], **Ballester J.**[2]

[1]Abastumani Astrophysical Observatory, GE-383762 Abastumani, Georgia

[2]Universitat de les Illes Balears, E-07122 Palma, Spain

Observations reveal an increase with height of the line width of several coronal spectral lines probably caused by outwardly propagating Alfvén waves. However, the spectral line width shows a sudden decrease at a height ∼0.1–0.2 R_{sun}, an effect that can be explained by a reduction of the wave amplitude. The Alfvén wave amplitude can be reduced either by wave damping or due to its transformation into another type of wave motion. Recent modelling of the plasma β with height (Gary, 2001) shows that β may approach unity at relatively low coronal heights, just where the spectral line width decrease is observed.Here we show that the spectral line width reduction can be caused by the resonant energy conversion from Alfvén to acoustic waves at the $\beta \sim 1$ region of the corona.

✓ SOLAR CYCLE VARIATIONS IN THE SUN–EARTH SYSTEM: POSTER

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Similarity and Difference of the Small-Scale and Middle-Scale Solar Wind Structure Boundaries by Two-Point Observations

Zastenker G.N.[1], **Riazantseva M.O.**[1,2]

[1]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

[2]Skobeltsyn Institute of Nuclear Physics, Moscow State University, RU-119992 Moscow, Russia

This report presents the observations of the very fast (from several seconds till hundred seconds) and large (from 20% up to several times) changes in the solar wind ion flux. These changes are connected to the sharp boundaries of solar wind small-scale and middle-scale structures. Such boundaries may be as thin as tens proton gyroradii or less.

The observations were performed aboard the Interball-1 satellite with very high time resolution (1 s or 60 ms) and "simultaneously" by the WIND spacecraft with time resolution 3 s. It was founded that almost for each case of the sharp boundary observation by Interball-1 we can find the similar event in the measurements of the WIND in spite of separation between spacecraft up to about mln. km.

So, we can demonstrate several tens of cases when the very fast changes of solar wind ion flux and magnetic field hold the duration of their fronts (about 10 s or less) and their amplitude (about 1.5–2 times) during the propagation (up to one hour) from one spacecraft to the other.

But as addition – in many cases we found that the rather smooth fronts (with duration about 20–100 s), recorded by WIND at the distances along Xse line about 50–200 Re, observed as the significantly more steeper ones (about 3–10 s) by Interball-1 at the distance 15–20 Re from the Earth. Such difference may be explained by local irregularity of the disturbance fronts or by their real steepness. Statistics allow us to suggest that the second reason also take place.

✓ OTHER RELATED TOPICS: POSTER

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Current Structures in the Earth's Magnetotail

Zelenyi L.M.[1], **Milovanov A.V.**[1], **Popov V.Yu.**[2], **Malova H.V.**[3,1]

[1]Space Research Institute, Russian Academy of Sciences, RU-117997 Moscow, Russia

[2]Moscow State University, RU-119992 Moscow, Russia

Introduction

Magnetic tail of the Earth is produced in the course of interaction of supersonic stream of solar wind plasma with the rather strong (on cosmic scales) magnetic field of our planet. From the plasma physics point of view magnetotail could be considered as a self-consistent high-beta configuration where hot plasma is confined by the pressure of magnetic field generated by currents flowing within this plasma. From thermodynamic point of view magnetotail could be considered as nonlinear open system where the incoming flux of solar wind energy is transformed into kinetic and thermal energies of magnetospheric and ionospheric plasmas.

Thin current sheets and their fine structure

Experimental findings of the last decade (INTERBALL, GEOTAIL, CLUSTER measurements) shed a new light on the physics of magnetotail plasma system (*e.g.* exploration of a very thin current sheets) and motivated a number of theoretical studies. Very thin current sheets with thicknesses about ion gyroradius (TCSs) are remarkable, almost singular layers of very concentrated currents. Kinetic theory explains many features of such sheets including their thickness, their possible bifurcations and occasionally appearing

very thin sublayers of strong electron currents. We discuss the peculiarities of CS magnetic field profile and corresponding multilayer structure of cross tail current. Numerical simulations indicate on a possibility of ion current reversal in a center of TCS and existence of self-consistent structure with triple-humped current profile. Very narrow peak of electron current associated with a curvature drift of anisotropic electron component might produce significant steepening of magnetic field profile at the center of CS. All these features which could be observed in magnetic field satellite measurements reflect intrinsic properties of CS equilibrium and might be used for its diagnostic.

Multiscale structure of "turbulent" current sheets

Laminar sheets discussed above typically exist at closed field lines and are characterized by thin cross tail current profile (often bifurcated). 'Turbulent' sheets have more chances to be observed far downstream of the tail at open filled lines where magnetic component normal to CS plane vanishes to very small values, non-capable to provide "rigidity" to field lines which becomes stochastic. Conditions in the Earth's magnetotail as in an open system filled by high beta plasma are favorable for self-organization to hierarchy of multiscale structures. Complex topology of magnetotail field is self-consistently coupled to the distribution of plasma currents which particles should carry moving in such entangled magnetic geometry. Assumption about self-similarity of structuring (conforming with experimental data) allows to use methods of fractal geometry for description of processes in magnetotail. Such approach appears to be especially productive when magnetotail state is close so called non-equilibrium steady state (NESS).

We use fractional diffusion equation to describe interaction of particles with multiscale turbulent structures. The process resembles second order Fermi acceleration but generalized for non-Gaussian case. Resulting quasi-equilibrium particle distributions acquire power law tails characteristic for magnetotail plasma populations

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✓ CLUSTER OBSERVATIONS AND THEORY: ORAL

Effect of Solar Wind Dynamic Pressure Changes on Convection and the Aurora: Modeling and Observations

Zesta E.[1], **Boudouridis A.**[1], **Raeder J.**[2], **Larson D.**[2], **Lummerzheim D.**[3], **Strangeway R.J.**[4], **Lyons L.R.**[1]

[1]Department of Atmospheric and Oceanic Sciences, University of California Los Angeles, Los Angeles, CA 90095-1565, USA

[2]Department of Physics and Space Science Center, University of New Hampshire, Durham, NH 03824, USA

[3]Geophysical Institute, University of Alaska, Fairbanks, AK 99775-7320, USA

[4]Institute of Geophysics and Planetary Physics, University of California Los Angeles, Los Angeles, CA 90095-1567, USA

Recent studies have suggested that solar wind dynamic pressure enhancements can cause energetically very significant perturbations in auroral precipitation and ionospheric currents, thus having the potential for significant energy input to the Earth's upper atmosphere. It has been reported that pressure enhancements can cause significant and rapid closure of the polar cap and open flux, widening and strengthening of the auroral oval at all local times, as well as an increase of the cross polar cap potential (CPCP) and the efficiency of coupling of the solar wind to the magnetosphere. The effects are most dramatic during periods of strongly southward IMF B_z but are evident at various degrees under most IMF conditions. We investigate the physics driving such responses by comparing the observations (from Polar, DMSP, and FAST Spacecraft) with the results of the OpenGGCM MHD model, and we identify to what extent the MHD model can reproduce the observed responses. We have isolated a small number of cases where the solar wind dynamic pressure enhancement occurs under negative or near-zero IMF B_z. Perhaps the most peculiar of the effects of pressure pulses is the rapid shrinkage of the polar cap as the increased solar wind dynamic pressure impacts the magnetosphere, at the same time when the CPCP increases. We investigate, through the model, the time development of the size of the open flux and of the auroral oval, and of the CPCP as well as the motion of the separatrix. Initial results indicate that when IMF B_z is steady, either southward or near zero, the model reproduces very well the direction and timing of the change of the open flux and that of the CPCP after the compression. The agreement is not good at times of more variable IMF.

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Waves and Instabilities in Flowing Solar Wind Structures in the Framework of the Hall Magnetohydrodynamics

Zhelyazkov I., **Miteva, R.**

Faculty of Physics, Sofia University, 5 James Bourchier Blvd., BG-1164 Sofia, Bulgaria

Now it is well established that the solar atmosphere, from the photosphere to the corona and the solar wind is a highly structured medium. Satellite observations have confirmed the presence of steady flows. Bulk motions are registered along or nearly along the magnetic field lines which outline the magnetic structures. Recent observations made by two HELIOS spacecrafts have revealed fine

structures in high-speed solar wind flows. These structures are in the form of thin flow layers (or tubes) that are adjacent to each other with differences in their plasma parameters (density, magnetic field, steady flow-speed). The structures can be separated by tangential discontinuities in the magnetic field, across which the total (kinetic plus magnetic) pressure is continuous. Here, we investigate the parallel propagation of magnetohydrodynamic (MHD) surface waves traveling along an ideal flowing plasma slab surrounded by flowing plasma environment in the framework of the Hall magnetohydrodynamics. The magnetohydrodynamics with Hall effect (Hall-MHD) gives a fluid description of magnetized plasmas taking into account scales of the order of the ion-inertial length, $l_{\mathrm{Hall}} = c/\omega_{\mathrm{pi}}$, at which the dynamics of ions and electrons separates and the medium becomes dispersive. The magnitudes of the ambient magnetic field, plasma density and flow velocity inside and outside the slab are different. Two possible directions of the relative velocity (in a frame of reference co-moving with the ambient flow) have been studied. From the two kinds of surface-wave modes that can propagate, notably sausage and kink ones, the dispersion behavior of the kink mode turns out to be more complicated than that of the sausage mode. In general, the flow increases the waves' phase velocities comparing to their magnitudes in a static Hall-MHD plasma slab. Moreover, it (the flow), at some values of the magnetic Mach number (the ratio of flow speed to the Alfvén speed), may cause the triggering of the Kelvin–Helmholtz instability. The applicability of the results to real solar wind flow-structures interacting with the Earth magnetosheath is also discussed.

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